Life Process-I

- **Living things:-** Living things are complex organizations of molecules, which perform certain life processes such as growth, metabolism, reproduction etc. that distinguish them from non-living matter.
- **Life processes:-** The processes which together perform the job of maintenance and are essential for sustaining life are called life processes.
- **Physiology:-** it is the branch of science which deals with the study of functional aspects of life processes. Some important life processes which are needed for living are:

1. **Nutrition:** It is the process by which organisms obtain their own food and procure it and utilize it. This is known as nutrition.
2. **Respiration:-** It is a process which involves gaseous exchange i.e. intake of oxygen and release of CO_2 and breakdown of food to release energy inside the cells.
   It involves two processes i.e. breathing and cellular oxidation. Breathing is simply the gaseous exchange. When we inhale O_2, it binds with Hb in the blood to reach every cell of the body. There in a cell the oxygen burns food for energy and this energy is released in the form of ATP molecules. The by-product of this reaction is CO_2 which is exhaled by the body. This is known as oxidation (of food).
   In nutshell, respiration is breakdown of food through oxidation and release of ATP energy for cellular activities.
3. **Transportation:-** It is a process in which substances synthesized or absorbed in one part of the body are carried to another part of the body.
4. **Excretion:-** It is a process by which living organisms get rid of excess of metabolic waste from the body.
5. **Movement and locomotion**
   a) **Locomotion:-** It is a process by which living organisms as a whole move from one place to another.
   b) **Movement:-** It is a process in which living organisms exhibit movement of their body parts only.
6. **Growth and development:-**
   a) Growth is defined as the permanent and irreversible increase in the size of an organism.
   b) Development is the whole series of changes which an organism undergoes during its life time.
7. **Control and co-ordination**:- It is a process through which organs interact with each other and compliment the functions of each other. It also enables an organism to receive information from their surroundings.
8. **Reproduction:-** It is a process of producing young ones of their own kind.

- **Metabolis**m:- It is defined as sum total of all the biochemical reactions that take place in our body. There are two types of metabolism:
  i) Catabolism ii) Anabolism

i) **Catabolism:-**It is the breakdown of complex molecules into simple molecules. It is associated with the release of tremendous energy and is called exergenic reaction. It is also known as destructive reaction e.g. digestion, respiration etc.

ii) **Anabolism:-** It is the synthesis of complex molecules from simple molecules in our body. Energy is absorbed during this reaction. Hence it is called exogenic reaction. It is also called as constructive reaction e.g. protein synthesis, photosynthesis.

- **Nutrition(Gk Nutritio - to obtain):** It is defined as a process by which living beings obtain food or synthesize it and change it into simple absorbable form through a series of biochemical processes is called nutrition.
- **Nutrients:-** The chemical substance present in the food are called nutrients. Thus, nutrients can be defined as substances which an organism obtains from its surroundings and use as a source of energy and for the biosynthesis of body constituents. Organisms obtain nutrition and nutrients from the food they eat.

- **Functions of food:**

Class :10th # Life Process-I **Biology**

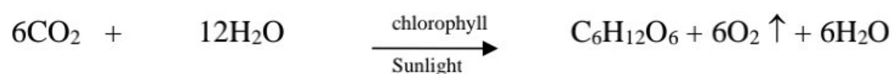
1. **Source of Energy:-** Food components on oxidation release energy which is used for carrying out various life processes. The heat produced maintains the body temperature.
2. **Formative functions:** Nutrients are used in synthesizing new protoplasm, replacing worn-out components of cells and increase in the no. and size of cells.
3. **Regulative functions:** Enzymes, vitamins, minerals and hormones control various metabolic reactions and activities and also help in maintaining good health and resistance against diseases.

Modes of nutrition:-Methods of obtaining food by the organisms, is called modes of nutrition. Depending on the modes of obtaining nutrients, all the organisms can be classified into two groups:

1. Autotrophic and 2) Heterorophic

1. **Autotrophic Nutrition:-** the word autotrophic has a Greek origin and is made up of two words: auto: self troph: nourishment/nutrition.

   In autotrophic nutrition, organisms manufacture their own food from simple inorganic raw materials present in the surroundings. The organisms which show the autotrophic mode of nutrition are called autotrophs. Depending upon the source of energy used in the preparation of food, autotrophic nutrition is divided into two types-photosynthetic and chemosynthetic.

- **Photosynthetic Nutrition:-** It is the characteristic feature of green plants. These plants trap solar energy and manufacture their food in the form of simple sugar from inorganic compounds like CO_2 and H_2O in the presence of chlorophyll. This process is known as photosynthesis. Such organisms are called photoautotrophs e.g. green plants and photosynthetic bacteria.
- 

$$6CO_2 + 12H_2O \xrightarrow[\text{Sunlight}]{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2\uparrow + 6H_2O$$

- **Chemosynthetic nutrition:-** In this mode of nutrition, organisms make use of chemical energy released during oxidation of simple organic compounds to prepare their food. Such organisms are called chemotrophs for example sulphur bacteria, iron bacteria, nitrosomonas bacteria etc.

  In sulphur bacteria a compound called hydrogen sulphide is oxidized to release energy.



$$CO_2 + 4H_2S + O_2 \rightarrow CH_2O + 4S + 3H_2O$$

2. **Heterotrophic Nutrition:-** The term heterotrophic also has a Greek origin and is made up of two words: Hetero: different troph: nourishment/nutrition.

   In heterotrophic nutrition, organisms can't prepare their food by themselves and are directly or indirectly dependent upen autotrophs of their food. Organisms which show this mode of nutrition, are called heterotrophs or consumers.

   Heterotrophic nutrition may be saprophytic, parasitic, holozoic and mixotrophic.

I- **Saprotrophic nutrition**:- In this mode of nutrition, organisms release some enzymes called hydrolytic enzymes to digest the dead organic food and derive nourishment from dead, decaying organic matter. A few animals also absorb soluble nutrients from non-living organic matter. Such a nutrition in animals is called saprozoic nutrition e.g.protozoans, nematodes(round worm, hook worm). Both saprophytic (mucor, soil bacteria, pseudomonas) and saprozoic nutritions togetherly are called saprotrophic nutrition e.g. mushroom, mould, yeast.

II- **Parasitic nutrition**:-It is a type of nutrition in which the organisms (or parasites) derive their nutrients or food from other living organisms (host). The organisms that provides nourishment is called parasite and the organism that supports or provides sustenance to a parasite, is called a host e.g. Plasmodium, Tape worm, cuscuta etc.

On the baisis of occurrence, Parasites are of two types:

i) **Endoparasites:-** Those parasites that live within the body of host and get nourishment from them are called endoparasites e.g. tapeworm, trypanosome, hook worm etc.

ii) **Ectoparasite**:- Those parasites which live on the body of host and generally attach themselves during feeding are called ectoparasite e.g. bed bug, head louse, mosquito, leech, lice, ticks etc.

On the basis of food habits parasites are further classified into two types:

i) **Total parasite/obligate parasites:-** Those parasites that completely depend on host for their nourishment e.g. tapeworm, round worm, cuscuta (plant) etc.

ii) **Partial or Facultative parasites:-** Those parasites that don't obtain whole of their nourishment from the host plant e.g. Mistle toe, sandal wood tree, lice, mosquito etc.

III- **Holozoic nutrition:-** It is that type of nutrition in which the organisms feed exclusively on the solid organic food materials. The food may be a whole plant or whole animal or their parts or it is defined as the feeding of complex organic matter by ingestion which is subsequently digested and absorbed.

It involves a no. of processes

1. **Ingestion:-**Taking in of complex organic food through mouth openings, is called ingestion. It occurs with the help of pseudopodia in amoeba, cilia in paramecium, tentacles in hydra, mouth parts in insects, hands in man etc.
2. **Digestion:-** It is the process by which complex, large sized, insoluble organic compounds like proteins, fats etc are changed into simple, small, soluble, diffusible organic compounds like aminoacids, fatty acids etc by the action of digestive enzymes secreted by digestive glands.
3. **Absorption:-**It is the process by which diffusible nutrients pass through the wall of alimentary canal especially small intestines into blood or lymph.
4. **Assimilation:-** It is an anabolic process by which simple nutrients are metabolized to resynthesize the complex biomolecules like proteins, fats, etc. It occurs inside the cells. The resynthesized biomolecules help in growth and repair of body tissues.
5. **Egestion**:- It involves expelling of undigested food in the form of faeces which contain excess of water and digestive enzymes.

Depending Upon Food habits Holozoic Animals Are Classified As:

Herbivores (L.herba = herb; vorare = to eat) :- These animals feed only on plants and plant materials for e.g. cow, buffalo, goat etc.

Omnivores:- These animals feed both on plant as well as animal matter for e.g. man, crow, bear, cockroach ant, etc.

Carnivores (L.cornis= flesh; vorare = to eat):- These animals feed on flesh of other animals e.g. lion, tiger, leopard etc.

Detritivores (Scavengers, carrion eaters):- Those organisms that feed on dead and decaying organic matter e.g. vultures, earthworms, etc.

Saguinivores:- These are the organisms that feed on blood of other animals e.g. leech, female anopheles etc.

Frugivores:- These are fruit eating animals e.g. birds, pets etc.

Insectivores:- These are the organisms that eat insects e.g. frog, toad, pitcher plant etc.

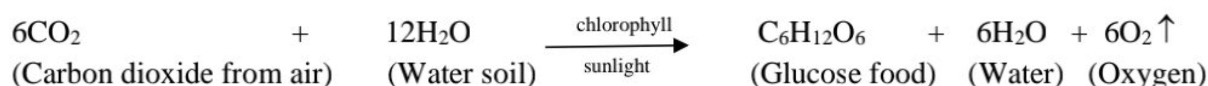
Difference between autotrophic and heterotrophic nutrition.

Autotrophic Nutrition	**Heterotrophic nutrition**
1. It occurs in green plants.	1. It occurs in plants which lack chlorophyll, insectivorous plants and animals.
2. The raw materials for this type of nutrition are CO_2 and H_2O.	2. They are directly or indirectly dependent on autotrophs.
3. Chlorophyll and sunlight are essential for it.	3. Chlorophyll and sunlight are not require for it.
4. They convert light energy into chemical energy.	4. They don't convert light energy into chemical energy.

IV- **Myxotrophic nutrition:**- It is that type of nutrition in which organisms show dual mode of nutrition e.g. some green species of euglena are autotrophic in presence of light but become saprophytic in dark.

- **Nutrition In Plants**:- Green plants make their food by the process of photosynthesis. It is the process of conversion of solar energy into` chemical energy. It takes place in the leaves of a plant.

- **Photosynthesis:** Photon: light; Synthesis: putting together. Green plants make use of molecules of CO_2 from air and H_2O from soil which breakup and recombine to form sugar and oxygen by utilizing solar energy in the presence of green pigment called chlorophyll. Thus during photosynthesis transformation of photonic energy (i.e. light or radiant energy) into chemical energy (locked in light energy bonds of carbo hydrate molecule) takes place. Hence, it may be defined as the synthesis of organic compounds (carbo hydrates) from CO_2 and H_2O by green plants using radiant energy or solar energy by chlorophyll. O_2 is evolved as a by-product. The process of photosynthesis can be represented by:



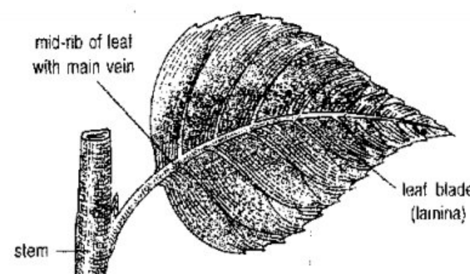
$$\underset{\text{(Carbon dioxide from air)}}{6CO_2} + \underset{\text{(Water soil)}}{12H_2O} \xrightarrow[\text{sunlight}]{\text{chlorophyll}} \underset{\text{(Glucose food)}}{C_6H_{12}O_6} + \underset{\text{(Water)}}{6H_2O} + \underset{\text{(Oxygen)}}{6O_2\uparrow}$$

The steps involved in photosynthesis are:

- Absorption of solar energy by chlorophyll.
- Conversion of light energy into chemical energy and also splitting of H_2O into O_2 and H_2 by light energy.
- Reduction of CO_2 to carbohydrates by utilizing chemical energy.

- **Leaf As A Photosynthetic Organ**

Leaves are the most suitable and well adapted organs to carry out the process of photosynthesis. In the leaves, the cuticle layer covers the outermost cellular layer, the epidermis. Below this layer, mesophyll tissue is present which is differentiated into palisade and spongy tissue. Chloroplasts are concentrated in the upper palisade layer of leaf. This helps them to obtain light energy very quickly. The spongy tissue inside the leaf provides easy diffusion of carbon dioxide. They also bear minute pores called stomata either on one or both the surfaces to facilitate exchange of gases between the leaf and the atmosphere.



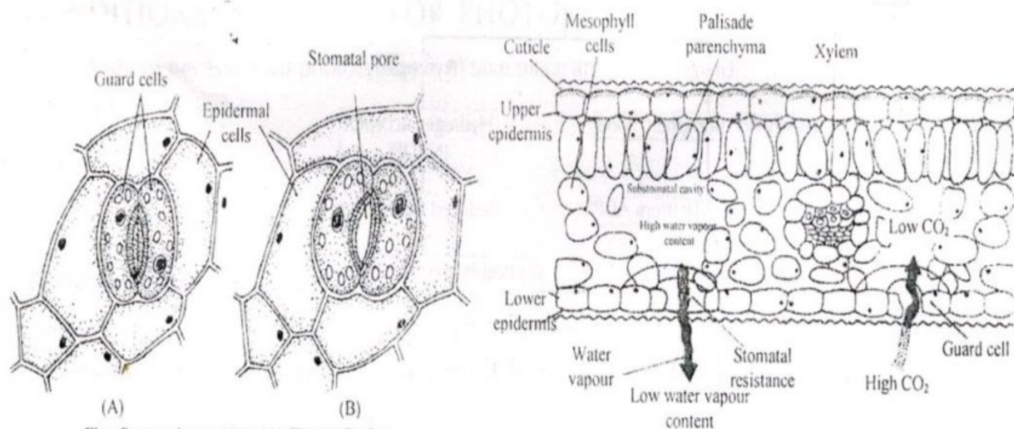


Fig : Stomatal apparatus (A) Closed (B) Open

Fig : Water movement through the leaf to the atmosphere in the form of vapour

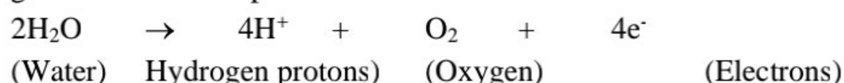
- **Chloroplast**:- Chlorophyll is essential for photosynthesis. It is present in the cell organalles called chloroplasts. Chloroplasts are green-coloured plastids. Each chloroplast is converted by a double-membrane. Inside the membrane, the center of chloroplast is filled with matrix or stroma. A no. of organized flattened membranous sacs called the thylakoids, are present in the stroma. Thylakoids are arranged in stalks like the piles of coins called grana or inter granal thylakoids. In addition, there are flat membranous tubules called the stoma lamellae connecting the thylakoids of different grana. The stroma of chloroplast contains enzymes required for the synthesis of carbohydrates and proteins. It also contains a small, double stranded circular DNA molecules and ribosomes. Chlorophyll pigments are present in thylakoids.

- **Raw materials for photosynthesis:**
  Following are the raw materials for photosynthesis:
  1. CO_2 2. H_2O 3. Chlorophyll 4. Sunlight

1. **Carbon dioxide:** The land plants take gaseous form of CO_2 which enters the leaf through stomata present on the epidermal layers. The stomata are minute pores guarded by two kidney-shaped guard cells. The guard cells regulate the opening and closing of stomatal aperture. The aquatic plants take dissolved form of CO_2 through the general surface of plant body. In submerged aquatic plant, the stomata are absent and absorption of water, mineral and gases occur through the general surface of plants.
   During early morning and evening hours, CO_2 is given out in plants through respiration and is then used by plants as raw material for photosynthesis. This time no net CO_2 is taken in by plants nor released. At this time, Rate Of Respiration = rate Of Photosynthesis. This is known as compensation point.

Compensation Point:- The point at which rate of photosynthesis and respiration in a plant are exactly balanced and one process uses up the products of other process, is called compensation point.

2. **Water:-** It is an important raw material for photosynthesis because it get's oxidized in presence of light to release necessary electrons and protons which pass through electrons transport system to generate the assimilatory power. H_2O is also responsible for the release of molecular oxygen which goes into the atmosphere.



   $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$
   (Water) Hydrogen protons) (Oxygen) (Electrons)

   Plants absorb H_2O from the soil through roots. The absorbed H_2O is then transported upward through xylem and reaches the leaves where it is utilized by process of photosynthesis in photosynthetic cells.

3. **Chlorophyll:-** It is of four types:
   Chlorophyll –A : It is blue-green in colour.
   Chlorophyll-B: it is green in colour.
   Xanthophills: It is yellow in colour.
   Carotenes: It is orange in colour.
   Chlorophyll-A and chlorophyll-B are light absorbing pigments. While as Xanthophills and Carotenes are responsible for imparting colour to fruits and flowers.

4. **Sunlight:-** It is a natural and prime source of energy and is used by plants only in visible light (violet, blue, red).

Mechanism of photosynthesis.

The study of photosynthesis demonstrated the existence of two phases, a light phase and a dark phase. The reactions of light phase require light and hence also called photochemical reactions whereas reactions of dark phase require no light (dark) and are purely chemical reactions.

A. Light Phase (Photochemical Phase)

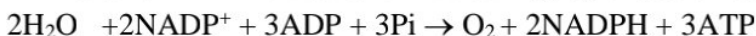
It can be studied under two headings:

1. **Absorption of light energy by chlorophyll:-** It takes place in grana region of chloroplast. During light reaction, radiant energy of sun is trapped by chlorophyll and accessory pigments. Pigment chlorophyll a absorbs visible light energy in the form of quanta or photons. When exposed to light, chlorophyll molecule is excited and emits electrons.
2. **Conversion of light energy to chemical energy and splitting of water molecule into hydrogen and oxygen:-** Emitted electrons from chlorophyll are channeled through electron transport chain in chloroplast. The energy absorbed by chlorophyll is responsible for carrying out three functions:
   a) **Formation of ATP:-** For the formation of ATP (Adenosine triphosphate), ADP (Adenosine diphosphate) joins a phosphate group. This formation of ATP from ADP during light phase is called photophosphorylation. The ATP thus formed is used as a source of energy during dark phase of photosynthesis.
   b) **Photolysis of water:-** The decomposition of water into hydrogen and oxygen by light energy (absorbed by chlorophyll) is called photolysis of water . Oxygen is released into atmosphere as by product of photosynthesis.



$$H_2O + \text{Energy} \xrightarrow{\text{photolysis}} 2H^+ + O_2 + e^-$$

   c) **Synthesis of NADPH (Reduced nicotinamide adenine dinucleotide phosphate):-** The released hydrogen ions from water are made available to NADP which gets reduced to NADPH. It is used in dark phase.
   ATP and NADPH molecules formed during light reaction together are known as assimilatory power.

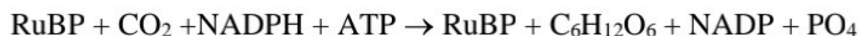


$$2H_2O + 2NADP^+ + 3ADP + 3Pi \rightarrow O_2 + 2NADPH + 3ATP$$

B. **Dark Phase (Light independent phase) or (Black reaction):-** Light independent reaction takes place in stroma of chloroplast. This reaction takes place only in absence of light and the whole process takes place in presence of many enzymes. As such it is also called as enzymatic reaction or enzymatic path way. In this reaction, ATP provides the energy while NADPH provides the electrons required to fixed carbon dioxide into carbohydrates.

It can be studied under the heading:

3. **Reduction of carbon dioxide to carbohydrate**:-Carbon dioxide is reduced to glucose (carbohydrate) by hydrogen in NADPH and by utilizing the chemical energy stored in ATP. Here CO_2 first of all combines with RuBP (Ribulose biphosphate). After a series of reactions, carbohydrate is synthesized and RuBP is regenerated. The overall reaction of dark phase can be represented as



$$RuBP + CO_2 + NADPH + ATP \rightarrow RuBP + C_6H_{12}O_6 + NADP + PO_4$$

It was discovered by Melvin Calvin and Any Benson, so it is also called as Calvin Benson Cycle.

Factors affecting photosynthesis

There are two types of factors affecting photosynthesis. They are:

External factors:-

- **Light:-** In photosynthesis, light is converted into chemical energy in the food so formed. It can be studied under following three headings:

i) **Light intensity**: Usually with increase in light intensity, rate of photosynthesis increases.

ii) **Light quality:-** Blue and red light of spectrum is said to be the best light for photosynthesis. The maximum photosynthesis is shown to occur in the red part of the spectrum with the next peak in blue part. The green light has an inhibitory effect on photosynthesis. But plants growing in deep water absorbs green light.

iii) **Light duration:-** Generally photosynthesis is independent of light duration. Plants which remain in light for 10-12 hrs are said to have high rate of photosynthesis.

- **Carbon dioxide:-** It is present in low concentration and form about 0.03 % of the total atmosphere CO_2 is one of the raw materials of photosynthesis. CO_2 is the natural limiting factor of photosynthesis. If the CO_2 concentration increases in plant body above 1 % it reacts with H_2O and forms carbonic acid. The rate of photosynthesis decreases due to closure of stomata.
- **Water:-** Out of the total amount of H_2O taken by plants, they use only 1-2% of it. Water deficiency may decrease photosynthesis because it is one of the important factors of this process. Less availability of water may further check the rate by closing the stomata, thereby affecting the entry of CO_2.
- **Temperature:-** The optimum temperature for photosynthesis is 18-35^{0}C. If the temperature is increased, the rate of photosynthesis decreases due to denaturation of enzymes involved in the process.
- **Oxygen:-** Excess of O_2 may become inhibitory for the process of photosynthesis. Enhanced supply of O_2 increases the respiration simultaneously decreasing the rate of photosynthesis.
  An increase in O_2 concentration decreases photosynthesis. This effect is known as Warburg effect.

Internal Factors

- **Chlorophyll:-** When the amount of chlorophyll is more, more absorption of solar energy occurs which will ultimately increase rate of photosynthesis.
- **Leaf anatomy**:- Size of leaf, its location and position in a plant affects rate of photosynthesis.
- **Accumulation of products**:- If no translocation of products occurs, rate of photosynthesis will decrease and it can even stop.
- **Photosynthetic /Assimilatory no:-** (Amount of CO_2 given by 1gm of carbon in 1 hr.) More the assimilatory number more will be the rate of photosynthesis.

Significance of photosynthesis

1. **Food:** By photosynthesis, green plants synthesize food from simple raw materials like CO_2 and H_2O. Thus, it sustains life on earth.

2. **Oxygen:** O_2 released during this process is needed by animals and humans. It is also required for respiration of microbes. O_2 also supports combustion of fuels.

3. **Fuels:-** Fossil fuels like coal, oil and natural gas are formed of stored solar energy synthesized by photosynthesis millions of years ago.

Prove that light is necessary for the photosynthesis.

We can prove that light is necessary for photosynthesis by performing an experiment. Take a potted plant. De-starch it by keeping it in dark for three days. Cover one of its leaves completely with carbon paper to avoid falling of light on it. Now put the plant in sunlight for 4-6 hours. Test the covered leaf and one of the uncovered leaves for the presence of starch. The covered leaf will show –ve test while the uncovered leaf will show +ve test for starch. This clearly shows that light are necessary for photosynthesis.

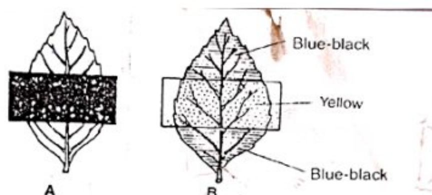


Fig. 4.15 : *Experiment to show that light is necessary for photosynthesis*
A. Leaf covered with black paper as shown and kept in light for 6 hours
B. Leaf tested for starch with IKI solution

Prove that O_2 is evolved during the process of photosynthesis.

We can prove that the O_2 is evolved during the process of photosynthesis by performing the following experiment:

Take a beaker, funnel, any aquatic plant (Hydrilla), test tube, water & a pinch of $NaHCO_3$. Fill half the beaker with H_2O. Place a few hydrilla twigs in it. Cover the twigs with the funnel. In the beaker, now add $NaHCO_3$. Invert the test-tube filled with water on the stem of funnel so that no air bubbles get in the test-tube. Keep the apparatus in the sunlight.

After some time, we will find that some gas has been collected in the test-tube and some bubbles are still coming up in the test-tube. The water level in the test tube comes down. On testing, it is found that the gas in the test tube is O_2 gas.

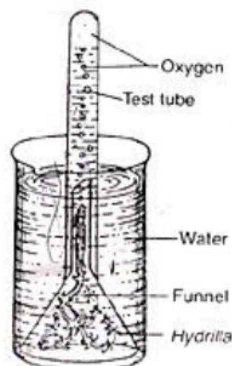


Fig. 4.17 : *Experiment to demonstrate the evolution of oxygen during photosynthesis*

Prove that CO_2 is necessary for photosynthesis.

To prove that CO_2 is necessary for photosynthesis. Take two de-starched potted plants and cover both the plants with transparent polythene or plastic bags. This would let light come in, but not fresh air. In one of the pots, keep NaOH (Soda Lime) that would absorb CO_2. In the other pot, place some sodium bicarbonate ($NaHCO_3$) solution, which produces extra CO_2. Keep both these pots in the sunlight for 4-6 hours and test one leaf from each potted plants for starch. The leaf from the pot that had soda lime will give –ve test for starch due to the absence of CO_2 while the leaf from the pot that has sodium bicarbonate will show +ve test for starch. It proves that CO_2 is necessary for photosynthesis in green plants.

Prove that chlorophyll is necessary for photosynthesis.

Take a potted plant like croton whose leaves are variegated (the leaves which are partially green and partially white). The green part has chlorophyll but white part does not have chlorophyll. Place this plant in completely dark place for 3 – 4 days to destarch the leaves. Take out to the plant from the dark place and keep it in sunlight for 3-4 days. Pluck the variegated leaf from the plant and remove its green colour by boiling it water. Wash the decoloured leaf with water to remove any chlorophyll stick into it. Pour iodine solution over the colourless leaf and observe the change in colour of leaf.

Observation:- We find that

a) Outer part of the leaf which was originally white does not turn blue black on adding iodine solution showing that no starch is present in this part of leaf and photosynthesis does not take place without chlorophyll.
b) Inner part of the leaf which was originally green turns blue black on adding iodine solution showing that starch is present in this part of leaf and photosynthesis takes place in presence of chlorophyll.

Conclusion:- This experiment shows that chlorophyll is necessary for photosynthesis.

Nutrition In Animals

Nutrition: - The sum total of processes (the taking in, breaking down, absorption and assimilation of food) by which living organisms obtain food and prepare them for use in growth, repairs and reproduction of energy is called nutrition. Or it may also be defined as the sum total of all process involved or concerned with the conversion of raw food stuff into usable and simple compounds to release energy is termed as nutrition.

The five steps in the process of nutrition are:

1. Ingestion 2. Digestion 3. Absorption 4.Assimilation 5. Egestion.

1. Ingestion:- The intake of food inside the body is termed as ingestion. Thus ingestion may be defined as a process by which the organism takes food. In man ingestion of food is done by the mouth.

2. Digestion:- It is a process in which complex food substances are broken down by the action of various enzymes into simpler soluble substances (cycle) which can be absorbed. In man, digestion starts in the mouth and continues on until the small intestines.

3. Absorption:- It is the diffusion of the digested food by the living parts of the organism. In man the digested food is absorbed in the small intestines through the intestinal wall having finger like projections known as villi.

4. Assimilation:- It means the incorporation of digested food substances into the living cells of an animal & the subsequent use for building up new tissues.

5. Egestion:- It is the process by which the undigested part of the food is thrown out of the body. In man, the undigested food enters the large intestines from where it is thrown out through the anus.

Nutrition In Amoeba:-Amoeba is a unicellular animal. Amoeba eats tiny microscopic plants (algae, bacteria) and animals which float water. The mode of Nutrition in Amoeba is holozoic. The process of obtaining food by amoeba is called phagocytosis.

Various steps in Nutrition of Amoeba

Ingestion:-Amoeba has no mouth for ingestion of food. Amoeba ingests food by using its pseudopodia. When a food particle comes near Amoeba, it ingests the food particle by forming pseudopodia around it. The food is engulfed with a little surrounding water to form a food vacuole inside the Amoeba. The food vacuole acts as temporary stomach.

Digestion:- In Amoeba food is digested in the food vacuole by digestive enzymes. The enzymes from cytoplasm enter food vacuole and breaks down the food into small and water molecules by chemical reaction, due to dissolved food.

Absorption:-The digested food present in food vacuole is absorbed directly into the cytoplasm of Amoeba cell by diffusion. Since amoeba consists of only one small cell, it does not require blood system to carry the digested food, the food vacuole disappears.

Assimilation:-Part of the absorbed food is used to obtain energy through respiration and the remaining absorbed food is used for growth of amoeba.

Egestion:- There is no fixed anus in amoeba. The digested food in amoeba is egested through the plasma membrane. The food vacuole bursts and opens and then disappeared.

Nutrition in human beings

Man is holozoic, omnivorous organism. The complex molecules that are present in the food cannot be utilized as such by the body cells. They have to be broken down into simpler forms before it reaches the cells. This chemical change is brought about by substances called enzymes.
Nutrition in man involves the steps such as ingestion, digestion, absorption, auuililation and egestion.

Digestive System of man

The human digestive system is a coiled, muscular tube extending from mouth to anus. It has several specialized compartments along its length: mouth, pharynx, oesophagus, stomach, small intestines, large intestines and anus. Accessory digestive organs are connected to the main system by a series of ducts, namely, salivary glands, parts of pancreas, liver and gall bladder.
It includes the alimentary canal and digestive glands that secrete enzymes into the canal through ducts.

1. **Alimentary Canal**:- It is differentiated into bucco-pharyngeal cavity, oesophogus, stomach and intestines.
   a. **Bucco-pharyngeal cavity:-** It consists of the mouth cavity and pharynx. The mouth cavity is formed by the cheeks (form the side walls), tongue (form the floor) and palate (form the roof). The palate is distinguished into the anterior hard and posterior soft palate. Mouth cavity has two openings at the back one, gullet, leading into the oesophogus and the lower one, glottis, leading into the trachea. Glottis is covered by a small flap like structure called epiglottis which prevents entry of food into trachea.
   Mechanical breakdown begins in the mouth by chewing and grinding of food by the teeth and of the tongue. This process is known as mastication.
   Tongue is a muscular organ, which is covered by a special type of mucous membrane. Besides, being the organ of taste, it mixes the food with saliva. It helps to form the food into a bolus before it is swallowed and passed into pharynx.

   b. **Pharynx:-** Pharynx is situated behind the tongue. It is short, funnel shaped structure arising from soft palate. It is divided into three parts: a) Nasopharynx b) Oropharynx. c) laryngopharynx. It is also called throat. Swallowing moves the food from mouth through the pharynx into the oesophogus and then to the stomach.

   c. **Oesophogus**:- It is a muscular tube, about 20cm long and lies in the neck and chest cavity. It open into the stomach. It has muscles which contract and relax rhytemically to push the food downwards. This rhythmic involuntary contraction and relaxation of smooth muscles of alimentary canal, is called peristalsis.

   d. **Stomach:-** It is large, somewhat J shaped muscular sac, situated just below the diaphragm towards the left side in the upper part of the abdominal cavity. It is highly elastic. It is formed of three parts viz cardiac stomach, body and pyloric.

Cardiac stomach:- It receives the oesophagus through an aperture called as cardiac aperture guarded by cardiac sphincter which prevents regurgitation of food. It is projected somewhat upwards and is called fundus.

Body:- It is main and middle part of stomach which is dome shaped.

Pyloric :- It is lower and narrow part which opens into duodenum. Inner lining of stomach is raised into large number of folds called gastric rague which dialates the stomach to store food and also increases surface area for digestion.

e. **Small intestines:-** It is about 6.5m long and is thrown into coiled loops, which fill most of the abdominal cavity. It is differentiated into three regions:- duodenum, jejunum and ileum.
Duodenum:- It is widest, shortest and c-shaped. It is about 25cm long. It receives common bile and pancreatic duct called hepato pancreatic duct.

Jejunum:- It is middle part and about 2.5m long.

Ileum:- Is is the longest part and about 3.7m in length. It opens into caecum. Both jejunum and ileum are highly coiled. Inner lining of small intestines is raised into 4 million minute finger like projections called as villi which increases the surface area for absorption of food.

f. **Large intestines**: It is about 1.5m long but it has a larger diameter than the small intestines. It is divided into three parts- caecum, colon and rectum.
Caecum:- It is a small pouch like structure which ends into tubular structure called vermiform appendix. Caecum and vermiform appendix are vestigial in function.
Colon:- It is long U shaped structure which is differentiate into four regions:
i) **Ascending colon**:- It extends upto liver on right side.
ii) **Transverse colon**:- It crosses the abdominal cavity below pancreas.
iii) **Descending colon:-** It runs downwards on the left side.
iv) **Sigmoid or pelvic colon:-** It is S shaped and opens into rectum.
Rectum:- It is slightly dialated part about 13cm long and is concerned with temporary storage of faeces. It leads to anal canal which opens out by anus.

2. **Associated or accessory digestive glands:-** Salivary gland, gastric gland, liver, pancreas and intestinal gland are the associated digestive glands.

a) **Salivary gland:-** It is the gland which secretes saliva and breaks starch and complex sugars into maltose. There are three pairs of salivary glands on the basis of their position but their function is same i.e. to secrete saliva into the buccal cavity.
i) Parotid ii) Sub-maxillary iii) Sub-lingual
Saliva:-It is a watery fluid which contains mucus for lubrication of food, salts which acts as buffer, antibacterial agents and an enzyme called salivary amylase or ptylin. It contains about 99.5 % water, 0.2% of minerals and 0.3% of organic matter. It has a pH of 6.8 and is slightly acidic in nature. Our mouth secretes 1-5 litres of saliva per day.

b) **Gastric gland**:- Stomach is divided into three parts. Similarly, gastric glands are divided into three types viz cardiac gland, pyloric gland and fundic gland.
The function of cardiac and pyloric glands is to make the medium inside the stomach alkaline.
Fundic gland consists of four types of cells which performs different functions.
i) **Chief Cells:-** It secretes two proenzymes pepsinogen and prorenin which helps in protein digestion.
ii) **Goblet Cells:-** It secretes mucus that helps in the lubrication of food.
iii) **Oxyntic cells:-** It secretes HCl which kills the germs in food, activates pepsinogen and prorenin, makes the medium acidic for the action of enzymes and deactivates salivary amylase.

iv) **Argentiffin Cells**:- It secretes gastrin hormone which induces the secretion of gastric acid (HCl)

c) **Liver:-** It is the largest gland, normally weighing about 1.5kg, situated just below the diaphragm in the risht upper part of the abdominal cavity. A pear shaped sac-like structure situated on the undersurface of liver, called gall bladder acts as a reserviour for storing bile secreted by the liver. Bile contains no enzymes but contains bile salts which help in digesting and absorbing fats (emulsification of fats). The daily secretion of bile is 600-1200 ml.

Liver is like a chemical factory which is involved in over 500 different kinds of functions like;

i) It converts ammonia into urea.
ii) It helps indigestion.
iii) It secretes anticoagulant "heparin" which prevents blood from being coagulated within the cells.
iv) It converts glucose into glycogen by the process of glycogenesis.
v) It is responsible for producing heat in our body.

d) **Pancreas:-** It is the second largest gland of our body. It is yellow coloured and is about 12-15cm in length. It lies at the loop of duodenum and is formed of head, body and tail.
It is a heterocrine gland i.e. it has an exocrine and an endocrine part in it.
The endocrine part consists of clusters of endocrine cells called as β-cells of iselets of Langerhanns which secretes two hormones i.e. insulin and glucagon.
The exocrine part secretes pancreatic juice which is rich in digestive enzymes. It contains pancreatic amylase, pancreatic lipase and trypsin. Daily secretion is 1500ml/ day.

e) **Intestinal gland:-** These are present in the lining of intestines. They are numerous and collectively secrete secretions. Intestinal gland is of two types:

i) Crypts of Liberkhun. ii) Brunner's gland.

They collectively secrete secretions called as intestinal juices or succus entericus and daily secretion is 1 ltre/ day.

Process Of Digestion

a) **Digestion in mouth:**

Digestion of food begins in mouth. The food ingested is chewed by teeth and is broken into smaller particles so that large surface area is provided for the action of enzymes. This process is called mastication. This food is then mixed with the saliva secreted by salivary glands which moistens and lubricates the food and help in swallowing. The enzyme salivary amylase (ptylin) acts on starch present in the food and breaks it into maltose in an alkaline medium.
The masticated food is now rolled into a bolus by the tongue and passed through the pharynx and oesophagus. During swallowing, the epiglotlis closes and prevents the food from entering the trachea. The food is passed along oesophagus by persistalsis.

b) **Digestion in Stomach:-** As the food reaches the stomach, it is mixed with the gastric juice secreted by the gastric glands. The food is churned by the contraction and relaxation of muscles of the stomach. Gastric juices contain dilute HCl, two enzymes rennin and pepsin, mucus. A small amount of gastric lipase is also present in it.

Pepsin:- It gets activated in acidic medium and acts upon the proteins to convert them into peptones.
HCl:- It kills the bacteria swallowed along with food, makes the medium acidic for the activation of pepsin and stops the action of salivary amylase.

Gastric lipase:- It partially breaks down the lipids.
Mucus:- It forms the inner lining of stomach and is secreted by the goblet cells of stomach. The function of mucus is to protect the lining of stomach from the action of HCl.

Renin:- It is present in children. It acts on milk protein "Casein" in presence of Ca salts and converts it into calcium paracaseinate. Pepsin then acts on calcium paracaseinate and converts it into Ca ions and peptones. While still in stomach, the food is churned by the muscular activity of the stomach to a creamy fluid called chyme. The food remains in stomach for a particular duration- carbohydrates (1-2 hrs) proteins (2-3 hrs), fats (3-6 hrs) and is periodically poured through the pyloric into the duodenum in small intestines.

Digestion in duodenum:
The chyme enters into the duodenum which receives two juices.
i) bile from liver b) pancreatic juices from pancreas

i) Bile helps in emulsification of fats i.e. breaking down of fats into fatty acids and glycerol, stops the action of gastric enzymes and also makes the medium alkaline for the action of pancreatic juices. Bile contains carbonate ions or sodium bicarbonate salts which makes the medium alkaline.

ii) Pancreatic juice contains following enzymes:
   a) **Trypsin:-** It converts remaining proteins into peptones and peptones into peptides and aminoacids.
   b) **Pancreatic amylase**:- It converts the undigested starch into maltose.
   c) **Lipase:-** It converts fats into fatty acids and glycerol.

The food now moves down to ileum and is formed in liquid state called chyle.

Digestion in ileum:
The food is slowly moved down to ileum where more digestive changes come into action. The intestinal juice called succus entericus contains the following enzymes which also acts in an alkaline medium.

i) **Erepsin or peptidase:-** It converts peptones into aminoacids.
ii) **Maltase:-** It converts maltose into glucose.
iii) **Lactose:-** It converts lactose into glucose and galactose.
iv) **Sucrase or invertase:-** It converts sucrose into glucose and fructose.
v) **Lipase**:- It converts fats into fatty acids and glycerol.

Thus, the digestion started in mouth is completed in small intestines. The digested food consists of simple sugars (monosaccharides), amino acids, fatty acids and glycerol.

❖ **Absorption of food:-** It is the process by which the products of digestion are taken into the blood stream. Most of the absorption of food materials takes place in the ileum of small intestines. The absorption surface is greatly increased by the presence of millions of finger like projections called villi. Each viilus is converted by epithelium and contains blood vessels and lymph vessels. Glucose, amino acids, minerals and vitamins are absorbed by the blood vessels while as fatty acids and glycerol are absorbed by the lymph vessels (lacteals).

❖ **Assimilation of food:**- The food after digestion and absorption is assimilated into the body substances and protoplasm of the cells. This takes place in following ways:-
1. Fatty acids and glycerol are used for deriving energy and for the formation of phospholipids. Excess fat is stored in the body in adipose tissue which can be utilized in times of need.
2. The simple sugars (monosaccharides) are used for generating energy for performing various metabolic activities. The excess glucose is converted into glycogen in the liver which can be reutilised during stress conditions.
3. Amino acids are used for the formation of nucleic acids and proteins.

Egestion:- The undigested semi-solid food which remains in small intestines is passed into large intestines. 95% water and salts are absorbed from it. The undigested waste called faeces is stored in the rectum from where it is egested through anus and this process of elimination of undigested food is called defecation or egestion.

Differentiate between

Ingestion	Digestion
1. In this step, the food is taken into the body. 2. There is no need of any digestive juices and enzymes.	1. In this step, food containing large insoluble molecules is broken down into small, water soluble molecules. 2. Digestive juices and enzymes are required

Ingestion	Egestion
1. The process of taking the food into the body is called ingestion. 2. Food is in solid or liquid form. 3. It contains roughage along with the food nutrient. 4. It is called feeding.	1. The process in which the undigested food is removed is called egestion. 2. It is in semi solid form. 3. It contains roughage and small amount of undigested nutrients. 4. It is also called defecation.

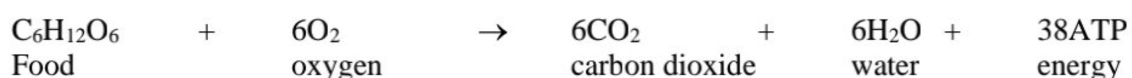
Absorption	Assimilation
1. The process in which the digested food passes through the intestinal wall into blood stream is called absorption. 2. The absorbed food is sent to different parts of the body. 3. The main site for absorption of food is small intestine.	1. The process in which the absorbed food taken in by body cells used for energy growth and repair is called assimilation. 2. The assimilated food is synthesized into protoplasm. 3. The main site for assimilation of food is Ribosomes.

Respiration:-

The phenomenon of release of energy by oxidation of various organic molecules for cellular use, is called respiration. The substances which are oxidized during respiration are known as respiratory substances. In broad sense, the process of exchange of gases between an organism and its environment resulting in oxidation of respiratory substrate to release energy, is called respiration. Respiration, thus involves:

a) **Breathing**:- The mechanism by which organisms obtain oxygen from the environment and release carbon dioxide is termed as breathing. It is a physical (extra cellular) process. No energy is released or no enzymes are involved in breathing. So, it is also called as extra cellular respiration.

b) **Internal Respiration**:- Respiration is a catabolic process going on in the cells of body at room temperature in which food is oxidized with the liberation of energy. Respiration involves taking in oxygen (of air) into the cells and using it for releasing energy by burning food and then eliminating the waste products (carbon dioxide and water) from the body. Respiration takes place inside the cells of the body hence it is called cellular internal respiration.
Carbon dioxide and water are by-products of cellular respiration. Carbon dioxide is waste product of respiration and is thrown out because its accumulation in the body is harmful to the organism. Water produced during respiration isnot harmful to the body.



$$\underset{\text{Food}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2} \rightarrow \underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{6H_2O} + \underset{\text{energy}}{38ATP}$$

Q Differentiate between:

Class :10th # Life Process-I **Biology**

Breathing	Respiration
1. It is physical process where only exchange of gases (oxygen and carbon dioxide takes place.	1. It is biochemical process where food (glucose) is oxidized to produce carbon dioxide and water.
2. No energy is released.	2. Energy is released.
3. It is extra cellular.	3. It is intracellular.
4. No enzymes are involved.	4. It requires many enzymes to bring about the oxidation.
5. It occurs in respiratory system.	5. It occurs in Mitochondria of cells.
6. Breathing involves the lungs of organisms.	6. It involves Mitochondria of cells.

Photosynthesis	Respiration
1. It takes place in green plants.	1. It takes place in all living cells.
2. It requires carbon dioxide, water, chlorophyll and sunlight.	2. It requires oxygen and food.
3. Food and oxygen are produced.	3. CO_2 and water are produced.
4. Energy is stored (endergonic).	4. Energy is released (exergonic).
5. It takes place only in sunlight.	5. It takes place throughout the life (day and night) of the organism.
6. It is anabolic activity.	6. It is catabolic activity.
7. Dry weight of organism is increased.	7. Dry weight of organism is decreased.
8. Enzyme are located in chloroplast.	8. Enzyes are located in mitochondria.

The respiration is just opposite to photosynthesis.

Photosynthesis: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O + ATP$

Respiration : $C_2H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

Respiration	Combustion
1. It takes place in living cells only.	1. It doesnot take place in living cells.
2. It is carried out with the help of various enzymes.	2. Enzymes are not involved in this process.
3. Oxidation of food and liberation of energy occurs in a stepwise manner.	3. The substances are oxidized spontaneously with sudeen release of energy.
4. It occurs at the body temperature of an organism.	4. Sudden release of energy generates high temperature.
5. 60% of energy escapes as body heat and 40% of energy is packaged directly into new chemical energy (ATP).	5. Energy released in combustion is dissipated as heat and to some extent as light.

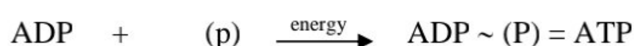
Q Respiration is a vital function of the body. Justify.

Respiration is a vital process and is essential for life because it provides energy for carrying out all the processes which are necessary for the maintenance of life and to keep the organism alive.

Q What is ATP and what is its role in respiration?

Ans. ATP means Adenosine Triphosphate. It is regarded as energy currency. ATP is infact tiny molecules formed in the cells which collect the extra amount of energy for future use.

When excess energy is released by combustion of molecules, it is used to make ATP from ADP and inorganic phosphate.



$ADP + (p) \xrightarrow{energy} ADP \sim (P) = ATP$

Each ATP molecule on hydrolysis releases 30.54KJ/mol of energy.

Q Which steps are involved in Respiration?

Ans. The two steps involved in respiration are:

a) Breathing
b) Oxidation of digested food

Q What is Respiratory Substrate?

Ans. The organic compounds which are oxidized during respiration are known as respiratory substrates e.g., Glucose.

Types Of respiration

There are two types of respiration

a) Aerobic Respiration
b) Anaerobic Respiration

Aerobic Respiration: - Aerobic respiration is the respiration which takes place in the presence of oxygen. It is completed into two main steps.

i) Glycolysis
ii) Krebs Cycle

In Aerobic respiration, the glucose (food) is completely broken down into carbon dioxide and water by oxidation and releases energy in the form of ATP. The breaking down of glucose during aerobic respiration is represented as



One molecule of glucose produces 38 energy rich ATP molecules. Organisms which obtain energy by aerobic respiration cannot live without oxygen because if there is no oxygen they cannot get energy from food.

In Glycolysis: Glucose is broken down to pyruvic acid with the release of some energy. This reaction occurs in cytoplasm.

In Kreb's cycle, TCA cycle, tricarbolic acidic cycle:- Pyruvic acid, in the presence of oxygen is completely oxidized to carbon dioxide and water with the release of more energy. This reaction occurs in Mitochondria of cell.

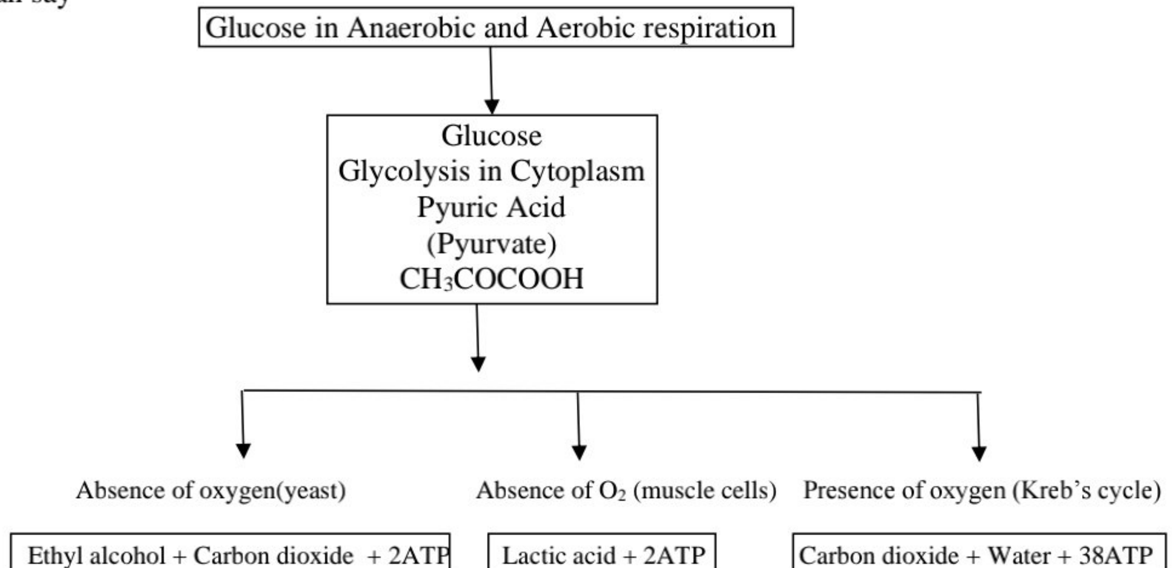
Anaerobic Respiration: Anaerobic respiration is the respiration which takes place in the absence of oxygen. Here Pyruvic acid undergoes two types of incomplete reductions.

i) In one, it results in the production of ethyl alcohol and carbon dioxide as in bacteria and yeast. Here it is called as fermentation and is brought about by a complex enzyme called zymase.
ii) In the other, it forms lactic acid as during the muscular exercise in the human body and in other animals.

Aerobic Respiration	Anaerobic Respiration
1. It takes place in presence of O_2.	1. It takes place in absence of O_2.
2. Substrate (glucose) is completely broken down.	2. Substrate is partially broken down.
3. The end products are carbon dioxide and water.	3. The end products are ethyl alcohol and CO_2 (in yeast plant) and lactic acid (in animal muscles).
4. Aerobic respiration produces a considerable amount of energy (38ATP molecules).	4. It produces less energy (2 ATP molecules)
	5. Anaerobic Respiration is carried out in cytoplasm (outside Mitochondria).

5. Glycolysis is carried out in cytoplasm (outside Mitochondria) while krebs takes place in Mitochondria.	6. Carbon dioxide may not be evolved.
6. Carbon dioxide is evolved.	7. It is less efficient process.
7. It is very efficient process.	

To sum up we can say



Respiration In plants
Respiration in Plants differ from respiration in Animals in three aspects.

Respiration in Plants	Respiration in Animals
1. All parts of the plant (root, stem and leaves) perform respiration individually.	1. An animal respires as a single unit.
2. Transport of respiratory gases (oxygen and carbon dioxide) is minimum.	2. Respiratory gases are transported over long distances in animals.
3. It takes place at a slow rate.	3. It takes place at much faster rate.

Respiration involves exchange of oxygen and carbon dioxide. So oxygen and carbon dioxide are respiratory gases. All the parts of a plant (like root, stem and leaves) perform respiration individually. During respiration, there is little transport of respiratory gases from one part of the plant to the other part of the plant. Respiration in plants takes place at a slow rate. All the parts of plants like roots, stem and leaves get oxygen needed for respiration by diffusion.

Respiration in Roots
Root hairs are involved in exchange of respiratory gases by diffusion. Root hairs are the extensions of the epidermal cells of a root. Roots take up oxygen present in between the soil particles by the process of diffusion. Oxygen (from air in soil particles) diffuses into root hairs and reaches the other cells of the root for respiration. Carbon dioxide produced in the cells of the root during respiration moves out from the same root hairs by diffusion. Thus respiration in roots occurs by diffusion of respiratory gases (oxygen and carbon dioxide) through root hairs.
Plant dies if its roots remain water logged for a long time because too much water expels all the air from in between soil for aerobic respiration and the roots are forced to respire anaerobically producing alcohol. This may kill the plants.

Respiration in Higher plants
Respiratory organs of higher plants are Lenticels and Stomata.

Lenticels:-
Lenticels are tiny apertures found in the stem regions, through which exchange of gases takes place between the air and living cells of the stem. Lenticels are present in hard, woody stems of large plants.

Stomata:
Stomata are the pores (openings) on the lower surface of the leaves through which exchange of gases take place between the air and the cells of the leaves. Water vapour from the leaves also goes out through stomata during transpiration. Soft stems of herbaceous plants also have stomata.

Role of Lenticels and Stomata in Respiration
During respiration, oxygen enters from the atmosphere to the plant body through them (lenticels and stomata) and carbon dioxide and water vapours come out from the same passage.

Respiration in Stems
Exchange of respiratory gases in the stems of herbaceous plants takes place through stomata. Oxygen from air diffuses into the stem of herbaceous plant through stomata and reaches all the air through the same stomata. Hard and woody stems of big plants do not have stomata, so exchange of respiratory gases in woody stems of big plants or trees take place through lenticels. Oxygen from air diffuses into the stem of woody plant through lenticels and reaches all the inner cells of the stem for respiration. Carbon dioxide produced during respiration diffuses out into the air through the same lenticels.

Respiration in Leaves
Exchange of respiratory gases in the leaves takes place through stomata. Oxygen from air diffuses into the leaf through stomata and reaches all the cells for respiration. Carbon dioxide produced during respiration diffuses out from the leaf into the air through the same stomata.

Respiration through body surface (cell surfaces)
In lower plants and animals like spirogyra, chlamydomonas, amoeba, paramecium, hydra, sponges, exchange of respiratory gases takes place through general body surfaces by diffusion.

Respiration In Animals
There is a constant exchange of gases between an organism and its environment. The surface of an organism where the gaseous exchange takes place is called respiratory surface. This surface is especially adopted for exchange of gases.
It must have following characteristics:
1) The respiratory surface must have a large surface area.
2) It should be extremely thin and moist for efficient diffusion.
3) It should be richly supplied with blood capillaries.
4) It must be permeable to respiratory gases.
5) There should be a provision for carrying O_2 to respiratory surface and carrying away CO_2 from the respiratory surface.

Organs of respiration in animal
In lower animals, like Amoeba, Euglena etc. no specific respiratory organs are present. In these animals exchange of gases takes place through the cell membrane by diffusion. In earthworm respiration is cutaneous i.e. it breathes through most skin-frogs respire through skin as well as through lungs. Thus, it shows both cutaneous as well as pulmonary respiration (through lungs). Insects contain small pores aon their bodies called spiracles which open into air tube like structures called trachea through which they respire. So, respiration of insects through spiracles and network of trachea, is called tracheal etc. respiration. Aquatic animals like fishes, prawnts contain gills. Fish have gills enclosed in gill chambers or operculum one on either side of the body just behind the head. Since the amount of O_2 dissolved in H_2O is fairly low, the aquatic animals must breathe faster to get sufficient O_2. Fish takes in H_2O through mouth and send it over the gills. The large surface of gills is lined with blood capillaries

where the dissolved O_2 is taken up by the blood and CO_2 is released into the external H_2O. Respiration through gills is called Branchial respiration.

Common Features of Respiratory Organs

Respiratory organs (skins, gills, trachea, lungs) have three common features.

i) All respiratory organs have large surface area to get enough oxygen.

ii) All respiratory organs have thin walls for easy diffusion and exchange of respiratory gases.

iii) All respiratory organs (skins, gills, trachea, lungs) have a rich blood supply for transport of respiratory gases. Only in tracheal system of respiration, air reaches the cells directly.

Respiratory System In Humans.

The process of respiration in human beings involves respiratory system which performs two main functions:

i) To breathe in oxygen needed for respiration.

ii) To breathe out carbon dioxide produced during respiration.

Respiratory system in animals is formed of two parts

1) Respiratory tract 2) Respiratory organs

I) **Respiratory tract:** It is the passage for transport of fresh and foul air and comprises of various organs.

1) **Nostrils or external nares:** It is a small pair of oval apertures at the base of nose just above the mouth.

2) **Nasal cavity or nasal chamber**: These are a pair of large chambers present above the bony palate. Nasal chambers are separated by nasal septum. Each nasal chamber is divided into three parts:

i) Vestibular part ii) Respiratory part iii) Olfactory part

Nasal cavity is lined by ciliated pseudo stratified columnar epithelium rich in mucus secreting cells. Both mucus and cilia check the entry of dust particles and microbes. Nasal chamber thus helps in:

- Warming of air
- Filtration of air
- Air moistening
- Sterilizing
- Smelling
- Air conditioning

Due to these functions, nasal respiration is advantageous over mouth respiration.

3) **Internal nares**: These are openings of nasal chambers which open in pharynx.

4) **Pharynx**: It is a common passage for the entry of food and air. It leads to trachea and oesophagus. The lower part of pharynx has silt like aperture called as glottis which always remains open except during food swallowing. The glottis bears the leaf like cartilaginous flap called epiglottis which closes the glottis during swallowing in order to check the entry of food into respiratory tract. Entry of food into respiratory tract can be fatal.

5) **Larynx or sound box or voice box:** It is a small thin walled tubular part present in neck. It is an enlarged upper part of trachea. It is more developed in males than in females after puberty. In males, it becomes permanent and protrudes outwards and is called "Adam's apple". Inside the larynx are two vocal cards. Vibrations in vocal cards results in the production of sound which is altered and converted into speech with the help of buccal cavity, soft palate, tongue and lips.

6) **Trachea or wind pipe**: It is a long, thin walled tubular structure. It is about 11 cm in length and 2.5 cm in diameter which runs downwards through the neck in front of oesophagus. It is supported by 16-20

incomplete c-shaped cartilaginous tracheal rings which prevent its collapsing. It is lined by ciliated pseudo stratified columnar epithelium with mucus secreting goblet cells.

7) **Primary bronchi:-** It is a pair of small thin walled tubular structures formed by the division of trachea. Each primary bronchi enters a lung of its own side and forms a bronchial intercom.

II: Respiratory Organs:

Respiratory organ in man are lungs, so it is called pulmonary respiration.

Lungs:

a. **Position:-** Lungs are a pair of soft, elastic and spongy organs present in thoracic cavity one on either side of heart. The thoracic cavity is separated from abdominal cavity by a muscular partition called diaphragm.

b. **Pleura**: It is thin, transparent two layered membrane. Between these layers, is a narrow cavity called as pleural cavity filled with a watery fluid called pleural fluid which performs three functions:
   i) It performs free frictionless movement of lungs.
   ii) It protects lungs from mechanical shock.
   iii) It keeps pleura together and lungs expanded.

Structure:

Each lung is conical shaped having upper apex and lower broader base. Right lung is slightly larger and broader in size.

Each lung is lobulated organ and is divided externally into lobes by transverse oblique grooves called fissures.

Left lung is divided into two lobes- superior and inferior lobes while as right lung is divided into three lobes- superior, middle and inferior lobes.

Left lung has a cardiac notch in order to accommodate heart.

Bronchial Intercom: It is a network present inside the lungs formed by the division and re-division of primary bronchus.

Right bronchus enters into right lung and divides into three smaller branches called secondary bronchi one going to each lobe of lung while as left bronchus enters into left lung and divides into two smaller secondary bronchi. Secondary bronchi further divides into still smaller bronchi called tertiary bronchi. Cartilaginous rings extend upto tertiary bronchi. Each tertiary bronchus further divides into still smaller branches called bronchioles. Each bronchiole further divides into minute branches called terminal bronchioles which further divide into respiratory bronchiole. Each of which divides into finest branches called alveolar duct, each of which opens into an alveolar sac or infundibulum or atrium.

An alveolar sac is formed of central passage and 6-8 pockets like outgrowths called alveoli or air sacs. Alveoli are the site of respiration. There are as many as 750 million alveoli in both the lungs which provides about $100m^2$ surface area for respiration which is about 50 times than that of skin ($1.6m^2$). So, lungs replace skin very effectively in mammals as organs of respiration.

Mechanism Of Breathing

Breathing is a mechanical process and it involves two steps:

1. **Inhalation or inspiration:-** During inhalation, the diaphragm, intercoastal muscles and thorasic cavity expands. This makes thorax to move upwards and outwards, thereby increasing volume inside thorasic cavity. This causes a decrease in air pressure inside. As a result, the air from outside rushes into lungs through nostrils, trachea and bronchi. Through the thin walls of alveoli, O_2 diffuses into the blood which then supplies this O_2 to tissues. It is then used by cells for cellular respiration.

2. **Exhalation or expiration:-** As a result of cellular respiration, CO_2 is produced. This CO_2 is absorbed by blood from the tissues and carried to alveoli of lungs. At this stage, the thorasic cavity returns to its normal

size due to relaxation of diaphragm and rib muscles and CO_2 is pushed out of body through nostrils and trachea.

Breathing is an involuntary process and the rate of breathing is controlled by respiratory centre of brain. An average rate of breathing in an normal man is 15-18 times/minute and the rate of breathing increases at the time of activities because demand of O_2 increases and there is an increase of 20-25 times /minute during vigorous physical exercise.

Mechanism of gaseous exchange between tissues and blood

When we breathe in air through nose, the air enters the nostril, passes through the nasal cavity, pharynx, trachea, bronchi and finally reaches the lungs. In the lungs, air passes through bronchioles and reaches the tiny air sacs called alveoli. Oxygen of air diffuses out from alveoli walls into the blood. The oxygen is carried by a red pigment called haemoglobin present in blood to all parts of the body. As the blood passes through the tissues of the body, the oxygen present in it diffuses into cells due to its higher concentration in blood. The oxidation of food (glucose) takes place in Mitochondria present in the cells. Carbon dioxide produced during respiration in the cells of the body tissues diffuses into blood due to higher concentration in body tissues. Blood carries carbon dioxide to the lungs. Carbon dioxide is removed with the air we breathe out.

Thus, blood which comes from the lungs has higher concentration of oxygen but the body tissues have higher concentration of carbon dioxide. It is due to this difference in concentration of oxygen and carbon dioxide, gases are exchanged between tissue and blood.

Transportation

The transport of substances like food, H_2O, O_2, enzymes, hormones etc. inside the body of an organism is called internal transport and the organs which carry out transport within the body constitutes the internal transport system.

Transport of Materials in Plants.

Plants absorb H_2O and minerals from the soil by their root system. Root hairs present on the root facilitate the absorption of H_2O and minerals. The absorbed H_2O and minerals have to be transported from roots to all the parts of plant. Similarly the food, which is prepared, has to be transported to various parts of the plant.

These functions of internal transport in plants are carried out by xylem and phloem. H_2O and minerals absorbed by the roots are transported through xylem tissue while as food prepared by leaves is transported through phloem. The upward movement of H_2O and minerals from roots to aerial parts of the plant against the gravitational force is called ascent of sap and the transport of food prepared the process of photosynthesis to various parts of plant is called translocation.

Transport of H_2O and minerals (ascent of sap).

Ascent of sap is carried out of xylem tissue. In flowering plants xylem vessels and tracheids conduct water and minerals and in non-flowering plants, tracheids are the only conducting cells. Trachieds are long, thin, spindle shaped cells with pits in their thick walls. Water flows from one trachied to another through pits.

The xylem vessels are elongated, non-living, lignified and placed end to end to form the pipeline for conducting water and minerals from roots to the leaves.

Minerals and H_2O needed by the plant are absorbed by the roots. The root hairs absorb H_2O from the soil by the process of osmosis and take in minerals by the process of diffusion. Thus a difference in concentration of ions is created between the roots and soil which enables the water to enter into the roots. This water along with dissolved minerals from root hairs passes into xylem and then ascent of sap takes place from xylem of roots into the xylem of stem and finally through xylem of leaf.

A continuous H_2O column flows from xylem of roots, xylem of stem and finally to xylem of leaf. This water column does not break due to cohesion and adhesion force. Evaporation of H_2O molecules from the cells of the leaf creates a suction force which pulls H_2O from xylem cells. Thus, cohesive and adhesive forces and transpiration pull help in the upper movement of sap from roots to leaves.

Transport of food and other substances (translocation)

The transport of food from leaves to different parts of a plant is called as translocation.

The food is manufactured in the leaf and is carried to phloem. The manufactured food that enters into sieve tubes of the phloem and transported as a dilute aqueous solution may be in upward or downward direction. Food is transported to all the non-green parts of the plant for growth and metabolic activities. Phloem also transports amino acids, hormones etc.

Translocation in phloem is achieved by utilizing energy. In this process, glucose is transferred to phloem tissue using energy from ATP. This increases the osmotic pressure of the tissue causing the water to move into it (endosmosis). Soluble material is then transferred from phloem tissue to other tissues which have less pressure than in phloem. Thus, according to plant's requirement, the material is translocated from higher osmotic pressure areas to lower osmotic pressure areas.

Transpiration

The loss of H_2O in the form of vapours from the aerial parts of the plant into atmosphere is called transpiration. Transpiration mainly occurs through stomata but it may also occur through cuticle and lenticles.

Types of transpiration

i) **Cuticular transpiration:-** It is the transpiration which occurs through cuticle (a waxy covering on the leaves and green stem). Upto 10% of total transpiration may occur through it.

ii) **Lenticular transpiration:** It is the transpiration which occurs through lenticles. Very small percent of transpiration takes place through lenticles.

iii) **Stomatal transpiration:-** It is the transpiration which occurs through stomata. About 80-90% of H_2O is transpired through stomata.

Transportation in human beings:

In case of humans, there are various things which needs to be transported from one region to another e.g. it has to carry urea from the liver to an area from which it can be excreted out of body. It depends upon pressure difference between two points and the substance goes from higher region to lower region. There are two transport systems in our body.

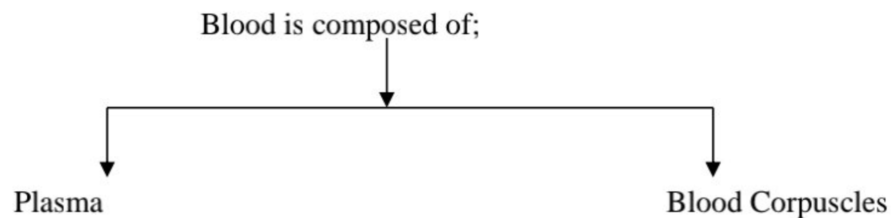
a) Blood vascular system
b) Lymphatic system

a) **Blood vascular system:-** A vascular system is that system which has tubes filled by fluid to be transported from one place to another. In case of humans, it comprises of heart which is a pumping organ to receive blood and blood vessels.

Blood:- It is a fluid connective tissue. It is reddish coloured due to presence of a pigment called as haemoglobin. This blood carries various functions in our body.

i) Circulation of blood is responsible for transportation of soluble digested food from small intestines to various parts of body. Blood also carries glucose from liver to muscles.
ii) Blood carries soluble excretory materials such as urea to organs of excretion.
iii) Blood carries hormones from endocrine glands to target parts.
iv) Circulation of blood helps to maintain constant body temperature by distributing excessive heat from deeply seated organs.
v) Blood transports O_2 from lungs to all parts of body.
vi) Blood carries CO_2 produced by the tissues to the lungs for breathing out.
vii) WBC of blood acts as soldiers of body by killing bacteria and other germs.
viii) It acts as a buffer and maintains a constant pH which maintains the concentration of solute potential of blood i.e. electrolytes.
ix) It regularizes the body temperature. It equalizes the body temperature by carrying heat from one region to another region of the body.
x) It helps in clotting the blood to prevent excess less of blood.
An adult contains about 6 litres of blood which is slightly alkaline in nature having pH 7.2 – 7.4.

Components of blood:- Blood is composed of;



Plasma

It is liquid part of blood in which different blood cells are present. It is straw coloured or can be colourless. It contains major portion of water (90%) and also (10%) of organic / inorganic substances. The different organic substances that are present in it are urea, amino acids, proteins, hormones and the different inorganic substance present in it are sulphates, phosphates, Mg. Besides, the organic and inorganic substances, it also contains a blood clotting protein called fibrinogen and also contains anticoagulant called heparin. If fibrinogen is removed from blood, it results in the formation of serum in plasma. (Serum- A blood plasma from which blood clotting protein is removed.

Function of plasma

1) It carries dissolved substances from one part to another part of the body.
2) It provides space for floating of corpuscles.
3) It carries food and waste to the cells for oxygen.
4) It carries dead remains of diseased bacteria and corpuscles to the proper organs.
5) It transports excretory matter.

Different types of blood cells:

RBC
WBC
Platelets

RBC's

These are also called erythrocytes. These are small, round, biconcave, disc-like structures that are thinnest at the centre. The real colour of RBC is pale yellow but appear red due to presence of haemoglobin. These are 7-8 um in diameter and are denucleated (to transport more O_2). In males, the no. of RBC's is 5.5 m/cm^3 and females have 4-4.5/cm^3. RBC have a life span of 120 days and main constituent of RBC is haemoglobin. Due to less presence of RBC's a disease called anaemia is caused which causes breathlessness. If there is more amount of haemoglobin present in blood, it leads to abnormal growth of RBC thus leads to cancer called polycythemia. Formation of RBC is called erythropoiesis and is formed in red bone marrow. These RBC's get degraded in liver. Shrinking of RBC's in liver is called erytopis. The content of haemoglobin in males is 15.5 $\pm$ 2.5 gm/decileter

In females it is 14.0 $\pm$ 2.5gm/decileter

In children it is 4 – 11.0 $\pm$ 2.5 gm/decileter (12 years).

WBC's

These are also called leucocytes. These are colourless and amoeboid shaped/ irregular). These are larger in size than RBC's and are fewer in number. The no. of WBC's in males and females is same -5000/mm^3. These are nucleated i.e. they have nucleus. There are various types of WBC's like monocytes. Basophills, neutrophills, eosinophills, lymphocytes.

WBC's are of two types:

Granular and agranular.

Granular WBC's:

These have granular cytoplasm and lobed nucleus. These are three types of basophills, neutrophills, eosinophills.

Agranular WBC's:

These have smooth cytoplasm and lobed nucleus e.g. monocytes, lympocytes.

WBC's don't have a particular life span because they are of different types. So, their life span varies like lymphocytes. They have a life span of almost 3-4 days. They provide immunity to body when foreign material enters our body i.e. antigen and our body responses to it. The WBC's engulf it and form a protein called antibodies. These are also called soldiers of our body.

Most WBC's are amoeboid and can throw out pseudopodia by which they can squeeze out through the walls of capillaries into tissues. This process is called diapedesis. If more no. of WBC are present in body it will lead to a disease (cancer) called leukaemia.

If less no. of WBC's is present, it will lead to a disease called leucopoenia. These are formed in white and yellow bone marrow.

Blood Platelets

These are also called thrombocytes. These are small, spherical structures numbering about 4,00,000/mm^3. These have life span of 2-3 days and are denucleated. It contains a blood clotting protein called thrombin. The function of B.P. is to form a solid plug at the time of injury which prevents further blood loss.

Blood Vascular System

It comprises of heart and blood vessels. (Arteries, Veins and Capillaries). Human circulatory system is closed because blood flows in blood vessels.

Blood vessels

These are hollow, tubular vessels which conduct blood from heart to body tissue and from the tissues to heart. These blood vessels are of three types.

Arteries

These are thick-walled which always carry blood away from heart to various body parts. These are elastic in nature, have narrow lumen, are deep seated in body parts and have no values in them. Blood flows at high pressure and speed. These generally carry oxygenated blood except pulmonary artery which carries deoxygenated blood from right ventricle to lungs. Average dia. is 500 microns. The wall of artery especially near heart is thick that enables them to dilate but not rupture when heart contracts and forces blood in them.

Veins

These are thin walled which always carries blood from various body parts to heart except pulmonary vein which carries oxygenated blood from lungs to left auricle. These are slightly elastic, have wide lumen, superficial in position and have valves in them to prevent back flow of blood. Blood flows through them at low pressure and speed.

Capillaries

The arteries further divide into thinner branches called arterioles inside the organ. Average dia. of arterioles is 120 um. Arteries further divide into smallest vessels called meta-arterioles which inturn divide into capillaries. These are thinnest B.V. with a dia. of 4-10um. Capillaries rejoin and form veins, venules and finally venacava with a dia of 10mm which come out of organ. So, capillaries join arteries and veins. These form a vast network of vessels. Blood flows very slow less than 1mm/sec which facilitates the exchange of food materials, gases and waste materials.

Heart

It is thick, muscular, reddish brown, conical organ made of cardiac muscles about the size of one's fist. It lies in thoracic cavity between the lungs immediately above diaphragm. Its lower conical part is titled to left and is enclosed in a bony cage formed of ribs, sternum (breast bone), back-bone.

It is about 12 cm long and 9cm broad. It is heavier in man than woman- 280-340gm in males and 230-280gm in woman.

Heart is enclosed in double layered membranous sac called pericardium. Between two layers of pericardium lies pericardial fluid which performs following functions.

i) It allows frictionless movement of heart.
ii) It protects heart from mechanical shock.
iii) It keeps the heart moist.

Human heart is four chambered and is divided into right and left half and each half consists of upper thin walled atrium or auricles and lower thick walled ventricles.
Auricles are receiving chambers and ventricles are pumping chambers. Walls of auricle are thin because they have to receive blood. Ventricle is thick because they have to pump blood.
Auricles are externally demarcated from ventricles by an irregular groove called coronary sulcus and ventricles are externally demarcated by a groove known as inter- ventricular sulcus. Internally two auricle are separated by inter auricular septum while as partition between two ventricles is called inter ventricular septum.
Right Auricle opens into rt. Ventricle through an aperture guarded by a value called as tricuspid valve. Similarly, left auricle opens into left ventricle through an aperture guarded by a valve called as bicuspid value or mitral value. At the base of aorta and pulmonary artery is present semi-lunar valve which prevents back flow of blood.
Right auricle receives deoxygenated blood from upper and lower parts of body by superior and inferior vanacava. Left auricle receives oxygenated blood from lungs by pulmonary vein. The largest artery in the body, the aorta arises from the left ventricle of the heart, goes up a little way, bends over, and then goes down through the chest and through the abdomen. The aorta gives of branches that go to the head and neck, the arms, the major organs of the chest and abdomen, and the legs. At the base of the aorta is a set of valves consisting of three crescent shaped cusps called as semilunar valve. The heart wall receives blood for its nourishment through the right and left coronary arteries which originate from the point where the aorta leaves the heart. After nourishing the heart muscles, blood returns through the coronary veins to the right atrium.

Cardiac Cycle Or Function Of Heart

The most vital function of heart is heart beat which takes place all the time throughout the life time. The sequence of events which take place during the completion of one heart beat or the period between the end of one heart beat to the end of next heart beat is called cardiac cycle. The normal rate of heart beat is 70-72 times per minute at rest and may increase to 100 or more during activities. Approx 5 litres of blood are pumped per minute. Cardiac cycle involves repeated, rhythmic contraction i.e. systole and relaxation i.e. diastole of heart muscles. Cardiac cycle is formed of three phases.

1) Atrial systole 2) 2) Ventricular systole 3) Joint diastole

1) **Atrial systole:-** It involves contraction of atria with pushes the blood to respective ventricles. As the right atrium and left atrium fills with blood, pressure in them increases, so that the auriculo- ventricular valves open and atria contract. Atrial contraction forces pumping of deoxygenated blood from right atrium to right ventricle through tricuspid value and oxygenated blood from left atrium to left ventricle through bicuspid value. Atrial systole takes about 0.1 sec.

2) **Ventricular Systole:-** It involves simultaneous relaxation of atria and contraction of ventricles. Due to ventricular systole, the pressure in ventricles increases the auriculo-ventricular valves close rapidly to prevent back flow. This closing of auriculo-ventriclar valve at the start of ventricular systole produces first heart sound called lubb or systolic sound. Finally, the pressure in ventricles increase, so semilunar valves open and blood enters into pulmonary artery and aorta. Deoxygenated blood from right ventricle enters into pulmonary artery which carries it to the lungs for oxygenation. Oxygenated blood from left ventricle enters into aorta which carries it to all parts of body. This takes about 0.3 sec.

3) **Joint Diastole/ Complete cardiac diastole:-** Ventricular systole is followed by joint diastole. As atria are already in diastole, so all the chambers of the heart enter the diastolic phase. Due to ventricular diastole, ventricles relax and the pressure in ventricles decreases than in aorta and pulmonary artery. It results in the rapid closure of semilunar valve. This rapid closure of semilunar valves at the beginning of ventricular

diastole produces the second heart sound called dupp or diastolic sound. Joint diastole takes 0.4 seconds. So, complete cardiac cycle is completed in 0.8 seconds.

Heart muscle contraction is due to the presence of nodal tissues in two regions of heart. The sino atrial node (S . A. Node) initiates the heart beat in the form of an electrical impulse that travelers down a special path way through the heart. The S. A. node is called the pacemaker of heart since it gives the heart beat regular. The atrio ventricular node (A.V.Node) causes the ventricles to contract.

Double circulation of Blood:

Mammalian heart is four chambers and has double circulation which means blood passes twice through the heart to supply blood once to the body. Double circulation involves two circulations.

1) **Systemic circulation:-** In this circulation, blood completes its circulation from left ventricle to right auricle through body organs. Here the left ventricle pumps oxygenated blood into aorta which supplies it to body organs other than lungs through a number of arteries. De oxygenated blood from these organs is returned to right auricle through large veins (pre and post vana cava). Right auricle pumps de-oxygenated blood in right ventricle.

2) **Pulmonary circulation**:- In this circulation blood completes its circulation from right ventricle to left auricle through lungs. Here right ventricle pumps de-oxygenated blood into pulmonary artery which supplies it to lungs where oxygenation of blood takes place. Oxygenated blood from lungs is return to left auricle by four pulmonary veins. Left auricle pumps the blood to left ventricle.

Lymphatic system:

It is the second important circulatory system that permeates through the entire human body and transports the liquid called lymph from body tissues to body vascular system. The lymphatic system is a network of tissues and organs that help to get rid of toxins, wastes and unwanted materials. It consists of:

1) **Lymph:-** It is light yellow colour, mobile, fluid connective tissue which drains into lymphatic capillaries from inter cellular spaces. It consists of two parts:
   a. Plasma b. Lymphocytic cells

   a) **Plasma:-** It is a fluid matrix which is somewhat similar in composition to blood plasma. It contains proteins, fats, germs and fragmented dead cells.

   b) **Lymphocytic cells**:- These are special cells which fights against infections.
2) **Lymph capillaries:-** These are blindly ending mesh work of thin walled and highly permeable tubes having variable diameter. The tissue fluid drains into lymph capillaries which join to form large lymphatic vessels.
3) **Lymph vessels**:- These are lymph containing vessels formed by joining of lymph capillaries. These are larger tubes resembling veins without valves. They join with the venous system near the heart. The tissue fluid flowing through the lymph vessels is slightly concentrated by the loss of water as it passes along the system.
4) **Lymph nodes:-** These are situated at intervals throughout the lymphatic system. Lymph nodes contain lymphocytes which accumulate in the lymph nodes where they produce antibodies and act as an important part of immune system. They remove bacteria and foreign particles from lymph.

Functions of Lymph

1) Lymph absorbs some of the fluid from digestive tract. It passes proteins to tissues. It carries digested fat.
2) It drains excess fluid from extra cellular spaces back in the blood.
3) It protects the body by killing germs.
4) It carries carbon dioxide and nitrogenous waste materials from tissues to blood.

Heart Beat

1. One complete contraction and relaxation of the heart is called heartbeat.
2. In normal person heartbeat is 70-72 times per minute or once after every 0.8 seconds.

3. Heartbeat is observed by stethoscope.
4. Heartbeats faster during and after exercise because body needs more energy under these conditions.
5. The heartbeat felt in the artery is called PULSE RATE. Normal pulse rate is 70-72 times per minute.

ECG- Electro Cardio Gram

The muscles fibres (or muscle cell) of the heart are specialized at certain parts of the heart, to generate electric currents that cause the normal rythemic heartbeats.

1. Electrocardiograph is an instrument to record heart beat which are generated by electric current by cardiac muscles which are involuntary in nature.
2. ECG or electro cardiogram is the graphical recording that indicates the area of malfunctioning of heart and extent of malfunctioning of heart.
   ECG has three parts: P wave, QRS complex and T wave. On analyzing the vital information of rate, rhythm of the heart and conditioner the heart muscles is provided.

Blood Pressure

1. The blood pressure is the pressure of the flow of blood in the aorta and its main arteries.
2. The BP varies according to contraction and relaxation of heart.
3. The BP exerted during relaxation of heart is called Diastolic pressure and it is 80mm of Hg.
4. The BP exerted during contraction of heart is called systolic pressure and it is 120mm of Hg.
5. Both the BP is usually expressed as 120/80 mm of mercury. (Normal BP for a man of 20years). Maximum BP should not exceed 150 in males and 140 in females.
6. Blood pressure is measured by Sphygmomanometer.

Opening and Closing of Stomata

Stomata (singular stoma) are the minute pores that are usually located on the lower epidermis. Each stoma is guarded by two kidney or bean shaped cells called guard cells.

The gases enter and leave the plants through the stomata. In most plants stomata are closed during night while they are open during daytime.

The opening and closing of stomata depends upon changes in turgor pressure of guard cells.

When water gets inside the guard cells, their turgor pressure increases and they expand. As a result stomatal pore opens.

When guard cells lose water, the turgor pressure inside guard cells decreases. This results in the closing of the stomatal pore.

Excretion:- Excretion, may be defined as the process of removal of intracellular metabolic wastes out of the body mostly in fluid form. In animals, the rate of catabolism is much higher than the rate of anabolism. Nitrogenous wastes produced during protein catabolism are highly toxic. If they accumulate in the body, they dis-balance the steady state and lead to death. Thus, they need to be de-toxified and then eliminated out.

Osmoregulation

It is the process of regulating the amount of wastes and ion concentration in the body of an organism.

Excretion and osmoregulations o side by side. The organ system responsible for excretion and osmoregulation is called excretory system.

Importance

1. Excretion removes the unwanted by products of metabolic pathway which unnecessarily hinder the biochemical reaction.
2. It removes many toxic chemical substances which damage the cells and act as enzyme inhibitors.
3. Excretion and osmoregulation regulate the ionic concentration of body fluid.
4. It regulates the H_2O content of the body fluid which is very important in maintaining the solute potential and volume of body fluid.
5. It is very important process as it helps in regulating the pH of body fluid.

Excretion In Plants:

Plants like any other living organisms also produce number of waste products. There are no excretory organs in plants. The excretory matter is accumulated in the plant body in the form of crystals, salts, resins, latex, tannins and carbon dioxide.

a) The main waste products produced by plants are carbon dioxide, water vapour and oxygen. The gaseous waste products (carbon dioxide, oxygen and water vapour) are removed through stomata in leaves and lenticels in stems.

b) Plants store some of the solid and liquid waste products in their body parts and shed these wastes by shedding leaves, peeling of bark and feeling of fruits. Some waste product of plants are useful to human. E.g. oxygen, gum, sandalwood oil, raphides, resins.
   Solid wastes: Raphides, rubber
   Solid waste product of plant present in yam (zamikand) in Raphides.
   Liquid wastes: Sandalwood oil, eucalyptus oil.
   Gaseous wastes: carbon dioxide, water vapour, oxygen.
   Some of the important excretory products in plants are:
   1. **Carbon dioxide:** End product of respiration plants excrete carbon dioxide during respiration only at night because during the day, the carbon dioxide produced is utilized for photosynthesis.
   2. **Oxygen**:- End product of photosynthesis.
      Excrete oxygen during daytime as photosynthesis occurs during daytime.
   3. **Water vapour**:- End product of respiration.
      Plants excrete it all the time (day and night).
   4. **Raphides:-**They are solid waste product of a plant which is stored in its fruits like yam (zamikand). They are made of calcium oxalate crystals, which make raphide needle shaped, and hence a fruit with Raphides can hurt the throat. This problem can be solved by eating sour substances (acidic) like tamarind, as Raphides as soluble in acids.
   5. **Rubber:-** Minerals salts like calcium carbonate or calcium oxalate are deposited as insoluble crystals called crystoliths, which are deposited in the leaves of Indian rubber.
   6. **Alkaloids:-**It is a nitrogenous waste and is poisonous if taken in higher quantities. They are also precursor of many herbal medicines e.g. quinine, caffeine, nicotine.
   7. **Tanins:-**They are found in the bark or fruits of some plants and used mainly for tanning leather.
   8. **Sectional oils:-**(Sandalwood oil, eucalyptus oil, clove oil and lavender oil). They are present in flowers like rose, jasmine etc. They give them sweet odour.
   9. **Organic Acids:-** These acids are found in some plant cells like citric acid in citrus fruits, tartaric acid in tamarind etc.

Difference between excretion and secretion

Excretion	Secretion
1. It is a process through which metabolic wastes are expelled out from the body.	1. It is a process through which products in the liquid form are secreted out in the glands.
2. It is a process of manufacturing excretory products.	2. Secretion is done in endocrine glands and exocrine glands.
3. Skin, lungs, liver and kidney are excretory organs.	3. In digestive glands, liver and in all the harmonic glands, secretion takes place.

Excretory products in animals: The chief excretory products in animals are the following:-

1. **Nitrogenous waste materials**:- Nitrogenous waste substances such as ammonia, urea or uric acid are produced during protein metabolism according to species. Small amount of nitrogenous wastes are also produced during metabolism of nucleic acids. Ammonia are most toxic followed by urea and uric acid. The latter is least toxic.
   i) **Ammonotelism:** The process of excretion of ammonia is termed as ammonotelism. Animals which excrete ammonia are called ammonotelic. E.g. Amoeba, Paramecium.
   ii) **Ureotelism**: Excretion of urea is called as ureotelism and the animals which excrete urea are called ureotelic. As urea is less toxic and less soluble in water than ammonia. Hence, it can stay for sometime in the body. E.g. Man and all other mammals.
   iii) **Uricotelism:-** Excretion of uric acid is called as uricotelism and the animals which excrete uric acid are called uricotelic. E.g. Uricotelic animals include most insects e.g. cockroach.

2. Mineral salts
3. Carbon dioxide
4. Water
5. Pigments
6. Vitamins and harmones

Excretion In Animals : Different animals have different arrangements (or organs) for excretion, which depend on the constitution of the animal. For example:

1. An Amoeba (and other single celled animals), the waste material carbon dioxide is removed by diffusion through the cell membrane, but nitrogenous wastes (like ammonia) and excess water are removed by the contractile vacuole.
2. In earthworm, the tubular structures called nephridia are the excretory organs. In addition to nephridia, the moist skin of earthworm also acts as an excretory organ.
3. Insects like centipedes, millipedes etc have tubular structures called malphigian tubules through which waste materials are expelled.
4. In human beings, the microscopic thin tubules form nephron, which functions as excretory unit. About 1 million nephrons taken together form the excretory organ of human beings called kidney.

Excretory System Of Humans:

1. **Kidney:** Kidney's are reddish brown, bean shaped located towards the back of the lower part of the abdominal cavity, one on either side of the backbone. Left kidney is slightly larger and placed a little higher than the right kidney (R. kidney has the pressure of liver). It is 10cm long, 5cm broad and 4cm thick and weighs 150gms. On the top of each kidney, is a gland called adrenal gland.
   Kidney has a convex and a concave side. Concavity of kidney is called hilum or hilus which is always inwardly directed. It guards the entry and exit of blood vessels (renal artery, renal vein). The hilum leads to a flat, funnel shaped space called renal pelvis. Each kidney is embedded in renal fat.
   Internally, each kidney is formed of about one million nephrons surrounded by a tough white fibrous capsule called renal capsule which is smooth and transparent. It encloses and protects the kidney and also helps to maintain the shape of the kidney. Renal capsule has two regions:-
   Outer-cortex and inner- medulla

   i) **Renal Cortex:-** It is the outer part of renal capsule which has reddish colour.

   ii) **Renal medulla:-** It is also red brown in colour. Inside the renal medulla are 5-18 triangular structures called renal pyramids.

   iii) **Renal pelvis:-** It is the urine collecting region where ureters leave kidney. Ureters originate from here.

2. **Ureters:-** These are a pair of long (25-30)cm narrow, muscular, tubular structures each arising from renal pelvis. Ureters run downward and open in urinary bladder.

3. **Urinary bladder:-** It is a large, thin walled, distensible, pear shaped sac present in pelvic region of the abdominal cavity. It temporarily stores the urine. It is distensible to store about 0.5-1litre of urine.
   Its upper part is called body of bladder and is concerned with storage of urine while its lower part is called neck of bladder. Neck of bladder is guarded by two sphincters which remain closed and open only at the time of micturation (urination).

4. **Urethra:-** It is a muscular and tubular structure which extends from neck of bladder to outside through urethral aperture. In females, it is about 4cm long while as in male; it is about 20cm long and is the common passage for urine as well as seminal fluid.

   Structure of Nephron

Nephrons are structural and functional units of kidneys which extracts wastes from the blood. Nephrons are also called as renal tubules or urineferous tubules. These are one million/ kidney. Each nephron is about 6cm long and is formed of two parts:

1) Bowman's capsule
2) Nephric tubule

1) **Bowman's capsule**:- It is a double thin walled cup shaped semi permeable structure present in the renal cortex. In the cavity of the Bowman's capsule, enters an artery called as renal artery which breaks down and forms a group of about 50 capillaries called glomerulus. It receives blood at high pressure from a branch of renal artery called as afferent arteriole.
Bowman's capsule and glomerulus are both collectively called as malphigian body or renal corpuscle or Pygmalion corpuscle and is about 150 um in diameter. These were first reported by Marcello Malphig

2) **Nephric tubule:-** It is long and coiled and is formed of:

a) **Proximal convoluted tubule (PCT):-** It is present in cortex and is convoluted. It is about 12-24mm in length. The cells have numerous mitochondria for active transport.

b) **Loop of Henle**:- It runs straight in the renal medulla. It is u-shaped and is formed of thin descending and thick ascending limb.

c) **Distal convoluted tubule (DCT):-** It is convoluted part and is again present in cortex. It opens in the collecting tubule.

d) **Collecting tubule:**- These converge in medulla and unite together in hilum to form collecting duct which finally opens in renal pelvis.
The artery that enters into the Bowman's capsule is called afferent arteriole and the artery that leaves the Bowman's capsule is called efferent arteriole. The veins that surround the nephric tubule are called vasa recta.

Mechanism Of Urine Formation:
Nitrogenous wastes are formed inside all the body cells. These wastes are transported to kidneys by blood and are changed into urine by 3 processes:

1. **Glomerular Filtration (OR) Ultra filtration):-** It is called so because this filtration occurs under pressure. In this filtration, a protein free fluid called glomerular filtrate or nephric filtrate or capsular filtrate or primary urine is filtered from the blood of glomerular capillaries to the lumen of the Bowman's capsule by a force called filtering force. The filtration occurs across a membrane made of the glomerular capillary wall and the inner membrane of the Bowman's capsule. The pores of this membrane are impermeable to large molecules or particles like blood cells & protein molecules. But smaller molecules like glucose, amino acids, urea , mineral salts are filtered into the Bowman's capsule and this process of selectively filtering out small molecules while keeping large ones like the proteins is called dialysis, the glomeruli of the kidney act as dialysis bags.

2. **Tubular reabsorption or selective reabsorption**:- The glomerular filtrate is moved in the nephron towards the collecting tubule. During its passage about 99% of H_2O, whole of glucose and Amino acids, most of Na^+ - Cl^-, some urea and uric acid are reabsorbed back in the blood and this process by which only useful substances are reabsorbed from the nephric filtrate in the blood, is called selective re-absorption.

3. **Tubular secretion (Augmentation):-** It is the process by which the glandular cells of nephron especially of DCT extract the wastes like uric acid, creatinine K^+, H^+, ammonia etc from the blood into the glomerular filtrate.

As a result of these three processes, the wastes are changed into urine. Volume of urine is much less than glomerular filtrate and its composition is also much different from that of glomerular filtrate due to loss and gain of substances in the tubule.

Renal failure (kidney failure)

At times owing to certain infection, injury or restricted blood flow to the kidneys, the kidneys are damaged i.e. stop working properly. In case of complete damage, the excretory products like urea are accumulated in the blood. Water level is also disturbed. This can result in the death of the person. In this situation two things are done.

1. Kidney transplant
2. Dialysis

1. Kidney transplant:- The damaged kidney is replaced by a matching kidney (from a healthy person) by a surgical operation.
2. Dialysis:- Dialysis is a process through which the urine is filtered with the help of artificial kidney. The process of purifying blood by artificial kidney is called haemodialysis.

Process of haemodialysis

1. Blood of patient is taken out from main artery, cooled to 0^0C and mixed with anticoagulant such as heparin.
2. Blood is pumped into an apparatus called artificial kidney. In this apparatus blood flows through channels or tubes having semi-permeable membrane of cellophane.
3. Cellophane tubes are kept in a dialyzing fluid which contains some small solutes and mineral ions. As the blood flows through these cellophane tubes, nitrogenous wastes like urea, uric acid, creatnine, etc. diffuse out in dialyzing fluid.
4. The blood that comes out of artificial kidney is pure blood. It is then warmed to body temperature and mixed with antiheparin to restore its normal coagulability and returned to a vein of patient.
5. Haemodialysis serves and prolongs the life of uraemic patients.

Role of various accessory excretory organs of man:-

There are four accessory excretory organs of man. These are:-

i) Skin. ii) Lungs iii) Intestine iv) Liver.

Excretory role of lungs:- The main gaseous waste is CO_2 & it is removed by exhaling in breath. The entire volume of CO_2, produced during respiration in the body is regularly excreted in the expired air by the lungs. The CO_2 is carried to the lungss, by the blood in the form of carboxy haemoglobin.

Excretory role of intestine:- The parts of the food material which remain undigested passes on to the large intestine from where it is thrown out through anus in the form of faeces. Besides this, the
intestine has a lining of epithelial cells which excrete certain salts, for instance, those of iron & calcium. These salts are excreted along with the faeces.

Excretory role of Skin: The skin behaves as an organ of excretion due to the presence of sweat glands & sebaceous glands in it. The sweat glands eliminate water, urea, NaCl, lactic acid, amino acids & glucose from the blood & excrete them on the surface of the skin. The subaceous glands secrete sebum which is a wax like secretion & eliminates some lipids such as waxes, sterols, other hydrocarbons & fatty acids on the skin.

Excretory role of Liver: The main nitrogenous waste is produced in the liver and is then finally excreted by the kidneys.

In the liver, the amino acids break down and results in the accumulation of nitrogenous wastes.

These nitrogenous wastes break down further into ammonia. Ammonia is very toxic, therefore liver converts ammonia along with CO_2 into urea with the help of specific enzymes. This urea is finally thrown out by the kidneys.

The haemoglobin of the dead red blood cells also breaks down in the liver. Liver manufactures bile pigments {bilirubin (brown or orange) & biliverdin (green)}from haemoglobin of the dead red blood cells. The bile pigments pass through the bile ducts into the intestine and are eliminated along with the faeces.

Physical Nature of Urine: Urine is a transparent, light yellow liquid with slightly acidic pH. The colour of urine is caused by the pigment urochrome, which is a breakdown product of the haemoglobin from worn out red blood corpuscles. The colour of the urine may be affected by foods such as beets, by vitamin supplements such as the B-complex or by certain medications. The pH range of urine is normally between 5.0 and 7.8 depending upon the amount of acidic and basic foods in the diet. Fruits increase the acidity and vegetables increase the alkalinity of the urine.

Composition:- About 95% of volume of urine is water, other substances are only 5%. Organic substances include nitrogen, urea, creatinine, ammonia, hippuric acid, amino acids, hormones, enzymes, etc. The inorganic substances include chlorine, phosphate, sulphate, potassium, sodium, calcium, magnesium, arsenic and lead. It is important to note that no glucose is normally found in urine.

Textual Questions

Q#1 Why is diffusion insufficient to meet oxygen requirement of multicellular organisms like humans?

Ans. In multicellular organisms like human beings only the cells of skin (surface layer) are exposed to surrounding environment. The rest of body cells of internal organs are not in direct contact with the surrounding environment. Hence, exchange of gases by diffusion may not be possible in these cells. Thus, multicellular organisms require specialized organs for breathing, exchange of gases and transport of gases to meet the oxygen requirement.

Q#2 What criteria do we use to decide whether something is alive?

Ans. If an organism shows the following characters, it means it is alive:

1. It is made up of cell/cells which has/ have protoplasm.
2. It shows movement and locomotion.
3. It requires food for performing life activities.
4. It respires and utilizes the inhaled oxygen for oxidation of food.
5. It has the ability to receive the stimuli and gives appropriate responses.
6. It shows growth and development.
7. It expels out metabolic wastes.

Q#3 What are outside raw materials used by an organism?

Ans. The outside raw materials used by an organism are:-

1. **Oxygen:-** It is used for respiration and production of energy i.e. ATP.
2. **Food:-** It is to be oxidized in order to release energy and for growth and maintenance of body.
3. **Minerals and vitamins**:- These are used for proper maintenance of body.
4. **Carbon dioxide:-** It is used by autotrophs for synthesis of food through photosynthesis.
5. **Water:-** It is used to perform all physiological processes.

Q#4 What processes would you consider essential for maintaining life?

Ans. The processes essential for maintaining life are – nutrition, respiration, transportation, excretion, control and coordination, movement and locomotion.

Q#5 What are the differences between autotrophic nutrition and heterotrophic nutrition?

Ans. Difference between autotrophic nutrition and heterotrophic nutrition

Autotrophic nutrition	Heterotrophic nutrition
1. It occurs in green plants, some bacteria and in some protista.	1. It occurs in plants which lack chlorophyll, insectivorous plants, and animals.
2. Chlorophyll is necessary for trapping sunlight.	2. Chlorophyll is absent as such they do not trap sunlight.
3. Food is self manufactured using carbon dioxide and water as raw materials.	3. Food is obtained directly or indirectly by consuming autotrophs.

4. Digestion of food does not occur. 5. They are placed at the bottom of food chain as producers.	4. Digestion is required. 5. They are placed above producers in the food chain as consumers.

Q#6 Where do plants get each of the raw materials required for photosynthesis?

Ans. Refer to notes.

Q#7 What is the role of hydrochloric acid in our stomach?

Ans. Gastric HCl performs the following functions:

1. It provides acidic medium which is essential for the activation and action of gastric enzyme pepsin.
2. It kills bacteria present in the food.
3. It converts inactive pepsinogen into active pepsin.

Q#8 What are the functions of digestive enzymes?

Ans. The major constituents of the diet are relatively complex such as carbohydrates, proteins, fats etc. which cannot be absorbed unless they are broken down into simple compounds. The function of digestive enzymes is to help in breaking down of complex food materials into simpler compounds which can be readily used by animals through absorption and assimilation. As such, digestive enzymes help in converting proteins into amino acids, fats into fatty acids and glycerols and carbohydrates into simple sugars.

Q#9 How is small intestine designed to absorb digested food?

Ans. Human intestine is several meters long. The internal lining of small intestine is folded and projected in the form of finger like structures called villi which increases the absorptive surface manifolds. Morover, villi are highly vascular containing blood capillaries and lymph capillaries. Furthermore, the lining of small intestine is very thin which facilitate rapid diffusion of substances.

Q#10 What advantage does a terrestrial organism have over an aquatic organism with regard to obtaining oxygen for respiration?

Ans. Terrestrial organisms consume atmospheric oxygen, while aquatic animals consume dissolved oxygen present in water. Air contains about 21% of oxygen while water has less than 1% oxygen in dissolved state. Oxygen diffuses through water much slower as compare to air. A terrestrial organism has the advantage of utilizing greater amount of oxygen at a faster rate with lesser effort whereas, aquatic organisms have to exert more effort to obtain the same amount of oxygen.

Q#11 What are the different ways in which glucose is oxidized to provide energy to various organisms?

Ans. In all organisms the first step in which glucose is oxidized is the breakdown of glucose, a six carbon molecule, into a three-carbon molecule called pyruvate. This process takes place in cytoplasm.

The fate of pyruvate depends upon the presence or absence of oxygen. Pyruvate may be converted into ethanol, carbon dioxide and 2 ATP molecules in the absence of oxygen. This process takes place in yeast during fermentation. It is called anaerobic respiration. Break down of pyruvate using oxygen takes place in mitochondria. This process breaks up pyruvate into carbon dioxide, water and 38 ATP molecules. It is called aerobic respiration. In case of lack of oxygen pyruvate breaks up into lactic acid as in muscles of human beings.

Q#12 How are oxygen and carbon dioxide transported in human beings?

Ans. In this exchange, the blood takes up oxygen from the alveolar air and releases carbon dioxide to it. Such an exchange occurs because the concentration of oxygen is more in the alveolar air. The blood has more concentration of CO_2 as compared to alveolar air. Thus the CO_2 moves from blood to alveolar air due to simple diffusion. This exchange of gases is called external respiration and results in the oxygenation of

blood. The oxygenated blood than returns from the lungs by pulmonary vein to the left side of heart supplies the oxygenated blood to the body tissues. The exchange of gases occurs between the oxygenated blood and the tissue cells. The concentration of oxygen is more in the blood and less in the tissue cells. So the oxygen moves from blood to the tissues and less in the blood and the CO_2 moves from tissues to the blood. This process is called internal respiration. The blood now becomes de-oxygenated.

Q#13 How are the lungs designed in human beings to maximize the area for exchange of gases?

Ans. Human lungs have a highly branched network of respiratory tubes. A primary bronchus divides into secondary bronchus, which in turn forms tertiary bronchus. Tertiary bronchus divides repeatedly into bronchioles which finally terminate into alveoli. Alveoli are small rounded pouches which are extremely thin walled and possess a network of capillaries. Exchange of gases takes place in alveoli and hence an alveolus is called miniature lung. The alveoli provide a vast surface area where exchange of gases can take place. Oxygen diffuses from alveoli into pulmonary blood capillaries and CO_2 diffuses out from capillaries into alveoli. It is estimated that the total surface area of alveoli of human lungs is about $100m^2$.

Q#14 What are the components of the transport system in human beings? What are its functions?

Ans. Refer to transportation in animals.

Q#15 What are the components of the transport system in highly organized plants?

Ans. Transport system in highly organized plants consists of two main components: Xylem and Phloem.

1. Xylem:- It is responsible for transport of water and minerals and its components are:-

1. (i) xylem vessels, (ii) xylem tracheids,
   (iii) xylem parenchyma, and (iv) xylem fibres.
2. **Phloem:-** It is responsible for transport of food substances and its components are:-
   (i) Sieve tubes (ii) Companion cells
   (iii) Phloem parenchyma (iv) Phloem fibres

Q#16 Why is it necessary to separate oxygenated and deoxygenated blood in mammals and birds?

Ans. The metabolic rate of their body is higher than those of other animals and as such their energy requirement is also more. For this, they need energy to maintain the body temperature. Thus it is necessary to separate oxygenated and deoxygenated blood so that the required amount of oxygen could be available to the cells and tissues.

Q#17 How is the amount of urine produced regulated?

Ans. The amount of urine produced is regulated by the hormone antidiuretic hormone (ADH) or vasopressin. The function of this hormone is to reabsorbed water from the nephric filtrate.

If in blood excess of water is present, less amount of ADH is secreted and more nephric filtrate is formed. As this filtrate passes through tubular part of nephron, less water is absorbed by blood capillaries. Hence, dilute and excess urine is passed out.

If in blood less amount of water is present, more ADH will be secreted, more water will be absorbed from nephric filtrate by blood capillaries surrounding the nephron, hence concentrated and less amount of urine will be passed.

Q#18 How are H_2O and minerals transported in plants?

Q#19 How is food transported in plants?

Ans. Refer to transportation in plants.

Q#20 Describe the structure and function of nephron.

Ans. Refer to excretion in animals.

Q#21 What are the methods used by plants to get rid of excretory products?

Ans. Like animals, plants also produce a number of waste products during their life processes. As compared to animals, plants produce waste products very slowly and in very small amounts. The plants have no special organs for waste removal like animals. The plants remove their waste products by different

methods, some of the important plant wastes and the methods by which they are removed are described below:

The main waste products of plant are:

1. Carbon dioxide 2. Water vapour 3. Oxygen

a) Carbon dioxide and waste vapour are produced as wastes during respiration by plants whereas the O2 is produced as a waste during photosynthesis. These gaseous wastes are removal through the stomata in leaves and lenticels in stems and release to the air.
b) The plants also store some of the waste products in their body parts e.g. some of the waste products collect in the leaves, bark and fruits of the plants. The plants get rid of these waste products by shedding of leaves, peeling of bark and felling of roots. Some of the plant wastes get stored in the fruits of the plant in the form of solid bodies called raphides.
c) The plants secrete their wastes in the form of gum and resins.
d) Some excretory products such as latex, gum, essential oils etc. are stored in special type of tissues and glands e.g. lactiferous tissue collect Latex which is the natural source of rubber, Resin ducts store resin and oil glands store essential oils etc.

Multiple Choice Question

1. The kidneys in human are a part of the system for
   a) Nutrition
   b) Respiration
   c) Excretion
   d) Transportation

Ans. c) excretion

2. The xylem in plants are responsible for;
   a) transport of water
   b) transport of food
   c) transport of amino acids
   d) transport of oxygen

Ans. a) Transport of water

3. The autotrophic mode of nutrition requires;
   a) carbon dioxides and water
   b) chlorophyll
   c) sunlight
   d) all of these

Ans. d) All of these

4. The breakdown of pyruvate to give carbon dioxide, water and eergy takes place in;
   a) cytoplasm
   b) chloroplast
   c) mitochondria
   d) nucleus

Ans. c) mitochondria

5. How are fats digested in our bodies? What does this process take place in?

Ans. Fats are digested in the small intestine. The secretion of liver, called bile breaks down the large globules of fat into smaller globules. This is called emulsification of fats. The bile also makes the medium alkaline so that the pancreatic enzyme containing lipase further digest fats to form fatty acids.

6. What is the role of saliva in the digestion of food?

Ans. Saliva contains salivary amylase and is released in our mouth. It breaks down starch into maltose (complex carbohydrates into simpler ones).

7. What is the necessary condition for autotrophic nutrition and what are its by-products?

Ans. For autotrophic nutrition to take place the conditions necessary are-light, chlorophyll, carbon dioxide and water. These all should reach a cell which contains chlorophyll in it. The by-product of the nutrition is oxygen which is released through stomata.

8. What are the differences between aerobic and anaerobic respiration? Name some organisms that use the anaerobic mode of respiration.

Ans. Refer to Notes

9. **How are the alveoli designed to maximize the exchange of gases?**

Ans. The alveoli are present at the terminal of bronchioles. They are balloon shaped structures which increases the surface area to about $100m^2$ for the exchange of gases and are richly supplied with blood vessels to take the oxygen to different cells.

10. Describe double circulation in human beings. What is it necessary?

Ans. Refer to notes

11. What would be the consequences of a deficiency of haemoglobin in our body?

Ans. Haemoglobin is a red pigment present in our body which carries oxygen to all the parts of the body. If there is deficiency of haemoglobin then amount of oxygen reaching our body cells will decrease which may lead to release of less energy in our body, leading to a disease called anaemia. Breathlessness, tiredness, weakness are the symptoms of anaemia.

12. What are the differences between the transport of materials in xylem and phloem?

Ans.

Transport in xylem	**Transport in phloem**
1. Water and mineral salts are transported. 2. The transport is generally passive.	1. Food in aqueous form is translocated. 2. The transport is active

13. Compare the functioning of alveoli in the lungs and nephrons in the kidneys with respect to their structure and functioning.

Alveoli	**Nephron**
1. It is the structural and functional unit of lungs. 2. It is thin walled, has a large surface area and is richly supplied with blood vessels. 3. It removes carbon-dioxide from the blood.	1. It is the structural and functional unit of kidneys. 2. It is thin walled, has a large surface area and is richly supplied with blood vessels. 3. It removes nitrogenous wastes from the blood.

Q Write a note on dental caries (tooth decay).

Ans. Dental caries is the most common disease of dental tissues, mainly of molars and premolars. It is more common in those children and adult persons whose diets are rich in carbohydrates which need less chewing and generally stick to the teeth.

- **Causative agent:-** It is caused by acidogenic (acid producing) bacteria of mouth, strepto coccus mutans, in the presence of high proportion of sugar. The bacteria cause an aerobic decomposition of sugars into organic acids.
- **Symptoms:-** Dental caries is characterized by gradual softening of enamel and dentine due to classification. Before this, the masses of bacterial cells and food particles stick to the teeth and form dental plague to cover the teeth. Finally, it leads to appearance of cavities in the teeth leading to inflammation and necrosis of pulp, called pulpitis.

Prevention:

i) Avoid sugar-rich eatables.

ii) Regular brushing of teeth after meals.

iii) Vigorous chewing of fibrous foods.

iv) Consumption of water containing 1ppm of fluoride.

v) Clearing of food particles from between the teeth by dental floss.



Coordination in plants

Plants do not possess nervous system and depend entirely on chemical coordination. Their responses are slower and they often involve growth. Growth in turn, can result in movement of an organ. Plants are coordinated by chemicals which have their effect on some aspects of growth, they are called growth substances. As some of these chemicals stimulate plant growth while some others retard the rate of growth, these chemicals are also referred to as plant growth regulators. Growth regulators include growth promoters (Auxins, gibberellins, cytokinins) as well as growth inhibitors (Abscisic acid). These are essential for the balanced and controlled development of plants. These are commonly known as auxins, cytokinins, gibberellins, abscissic acid and ethylene. These are also called phytohormones.

Plant hormones

Plant hormones are defined as the organic substances which are synthesized in minute quantities in any part of the plant and transported to another part where they are active. There are five main types of naturally occurring hormones. They are:

1. Auxins
2. Gibberellins
3. Cytokinins
4. Ethylene
5. Abscicic acid (ABA).

I. Auxin: The most common natural auxin is indole 3-acetic acid or IAA.

Discovery: - It was isolated for the first time by a Dutch botanist F.W. Went in 1928. The name Auxin was given by Went and he concluded no growth can occur without auxin.

Functions:

1. It promotes cell enlargement and cell differentiation in plants.
2. It is essential for the root formation on stem cuttings.
3. It suppresses the growth of lateral buds.
4. It promotes flowering in certain plants such as pine apple but delays it in lettuce.
5. Auxins are found to initiate many physiological processes, like protein synthesis, water uptake, respiration, seed germination.
6. It promotes fruit growth.
7. It prevents premature falling of leaves & fruits.
8. Auxins induce parthenocarpy in a number of plants.

Auxins are present in root and shoot apices.

II. Gibberellin: - They occur in roots, stem, leaves, flower buds, fruits and immature seeds.

Discovery: Gibberellins were discovered in 1926 by E. Kurosawa, a Japanese plant pathologist. Kurosawa while working in the rice fields observed that rice seedlings grew much taller than the others such plants were found to be infected by a fungus Gibberella fujikuroi. The disease was known as 'Bakanae disease' Yabuta and Sumiki (1938) demonstrated that some substance secreted by the fungus was probably responsible for enlongation growth of the seedlings. They isolated this substance from Gibberella fujikuraoi and named it Gibberellic acid.

Functions:-

i. G.ibberellin causes the elongation of stem and leaf sheaths.
ii. Gibberellic acid stimulates cell division.
iii. It helps in breaking the dormancy in seeds and buds.
iv. It also promotes fruit growth.
v. It includes parthenocarpy in many plants e.g. tomato.

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Cytokinins: - They are synthesized in root tips from where they reach shoots.

Discovery: Miller and Skoog in 1955 discovered a substance which was known to activate cell division. They named this compound as kinetin. The first natural cytokinin was zeatin.

Functions:

i) The most important function of cytokinins the promotion of cell division.
ii) Cytokinins along with auxins are required for the growth of cellular in tissue culture experiment.
iii) It promotes cell enlargement.
iv) It can break seed dormancy and also promote seed germination.
v) Application of cytokinins delays the phenomenon of senescence or ageing.
vi) It provides resistance to plants against very high and low temperature from injuries.
vii) In some cases cytokinins have been found to induce flowering.
viii) It enhances chlorophyll development and the rate of synthesis of chlorophyll.
ix) They over come apical dominance and allow sprouting of lateral buds.
x) It regulates phloem transport.

Ethylene: - Ethylene is present as a volatile gas in atmosphere. It is produced in all living tissues of plants. It moves through diffusion process.

Discovery:-Denny (1924) observed that ethylene gas was highly effective in inducing fruit ripening. Zimmerman et al (1931) found that it induces fruit ripening. Later on physiological studies led to discovery of ethylene as a natural product of fruit ripening.

Functions:-

1. It has inhibitory effect on growth.
2. It promotes transverse or is diametric growth and inhibits longitudinal growth.
3. It induces senescence or ageing.
4. It induces yellowish of leaves.
5. It induces flowering in some plants like pine apple.
6. Ethylene stimulates abscission of various plant parts.
7. It suppresses bud growth.
8. It induces ripening in fruit.
9. It induces epinasity. (downward bending of leaves)
10. It induces germination in some species.
11. It induces root their formation.

Abscisic acid– (ABA):- ABA are thought to be formed in leaves and then transported to apices through phloem. These work as growth inhibitors.

Discovery:-Corn and Addicot (1963) while working on shedding of cotton balls found that a chemical substance abcisin II is responsible for their shedding. This substance was named as Abscisic acid (ABA).

Functions:

1. It has inhibitory effect on growth.
2. It promotes senescence or ageing.
3. It promotes abscission or falling of leaves, fruits & flowers of plants.
4. It favours stomatal closure.
5. ABA plays an important role in plants during water stress and during drought conditions.
6. It is known to inhibit the process of flowering, fruit and seed development.

Plant Movement:-

These are the changes in orientation of some plant parts in relation to others caused by intrinsic (internal) or extrinsic (external) stimuli.

There are two types of movements shown by plants:
Growth movements (tropic movements or tropism) and
Non Growth movements (nastic movements)

Types of movements in plants

The movements in plants due to external stimuli are of two types:

i. Tropic movements
ii. Nastic movements

Tropic movements:- These are induced growth movements that occur due to differential growth. These are the unidirectional movement of plants in response to external stimuli such as light, force of gravity, chemicals, water, are called tropic movements. The movements are either towards or away from the stimuli. These movements are slow. The phenomenon of such movements is called as tropism. Depending upon the nature of external stimulus the tropic movements are of following types:

i. **Geotropism:-** The movement of a plant in response to the force of gravity is called geotropism or geotropic movement. Different parts of a plant respond differently to the stimulus of gravity. Primary root always moves in downward direction. This is known as positive geotropism. The shoot moves upwards just opposite to the force of gravity. Hence the stem of a plant shows negative geotropism.

ii. **Phototropism:-** The movement of plant organs in response to the effect of light is known as phototropism. In simple words the response of a plant to the light is called phototropism. When some parts of a plant for example stem moves towards the light it is called positive phototropism, on the other hand when some organs for example, roots move away from the light it is called negative phototropism.

iii. **Hydrotropism**:- The movement of plant parts in response to the effect of water stimulus is known as hydrotropism. In simple words the response of a plant part to water is called hydrotropism. If some parts of a plant move towards the water it is called positive hydrotropism. While if some plant parts move away from the water it is called negative hydrotropism. Roots are positively hydrotropic as they bend towards the source of water. Sporangiophores of many moulds grow away from moist substratum, there by showing negative hydrotropism.

iv. **Chemotropism**:- The movement of a plant part in response to the stimulus of a chemicals is called chemotropism. But if the plant moves towards the chemical stimulus, it is called positive Chemotropism. But if the plant moves away from the chemical stimulus it is called negative chemotropism. The growth of pollen tube through the style towards the embryo sac is the example of positive chemotropism. Roots grow away from harmful acids there by showing negative chemotropism.

Nastic movement

Nastic movements are non directional induced movements that occur due to turgor changes in the cells. Such movements are due to the stimulus of light, temperature or contact but the direction of response is determined by the direction of stimuli. However, from whichever direction the stimulus is applied, it affects all the parts of the organs of a plant equally and they always move in the same direction. They reveal immediate response to stimulus but do not involve growth.

Nastic movements are of the following two types:

i) Seismonastic movement ii) Nyctinastic movement

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i) **Seismonastic movement:-** These are the movements which occur in response to touch. The best example of seismonastic movement is the movement of the leaves of the sensitive touch me not plant Mimosa pudica. Leaves of touch me not plant droops rapidly when touched. It is due to turgidity of cells at the base. Here touch response is diffused affecting the entire leaf. Thus, the leaf droops down due to loss of turgor pressure. After sometime, the leaves regain their original shape. This phenomenon is also commonly called as thigmonasty.

ii. **Nyctinastic movement or Sleep movements: -** The diurnal (change in day and night) movements of leaves and flowers of some species in day and night are called nyctinastic movements. Since these movements occur in response to day and night, they are also known as sleep movements. These are movements due to turgor change in cells. Depending upon the stimulus they may be photonastic or thermonastic movements.

When the movement is induced by the change in light intensity, it is called photonastic movement e.g. dandelion flower. It opens in the morning in bright light and closes in the evening when the light fades.

The movement due to change in temperature, is called thermonastic movement. The flower of tulips (Tulipa) and Crocus show thermonastic movements.

Photoperiodism and flowering.

The length of the day (in hours) during which sunlight is available to the plants is called photoperiod. The effect of photoperiod on the germination of seeds and flowering in plants is called photoperiodism.

Photoperiod acts as a stimulus for plants. Plants respond to this stimulus with the help of a special kind of pigment present in them in very small amounts. The special pigment is called phytochrome which is a blue green pigment.

Garner and Allard in 1920 recognized three classes of plants according to their photoperiodic responses.

i) Short day plants ii) Long day plants and iii) Day neutral plants

i) **Short day Plants:-** A short day plant is one that flowers on photoperiods shorter than the critical day length e.g. tobacco plant.

ii) **Long Day Plants:-** A long day plant is one that flowers on photoperiods longer than critical day length e.g. wheat plants.

iii) **Day Neutral Plants:-** These plants do not require specific photoperiods to flower e.g. cucumber, maize, etc.

Coordination In Animals:

Evolution of multicellularity in animals necessitated the development of some system for the control and coordination of the activities of various cells of the body. Such a control and coordination, in fact, requires

i) Gathering information about changes in the external environment,

ii) Transmitting this information to the internal cells located away from the body surface, and

iii) Exchange of information between the cells situated away from each other.

In lower multicellular animals, the coordination takes place through the nervous system. However, in higher animals, coordination takes place through two types of control systems: nervous system and endocrine system.

1. **Nervous System:-** The nervous system is composed of specialized cells called neuron (nerve cells) which exercise control by sending electrical signals called

nerve impulses. The nervous control is speedy and flexible but its effect is localized.

2. **Endocrine System**:-The endocrine system consists of specialized glands (endocrine glands) which bring about control by sending chemical messengers termed hormones. The hormonal control is usually slow acting and its effect is diffuse.

Nervous System In Animals: Except sponges, all multicellular animals possess simple or complex nervous system. In all these animals, nervous system is comprised of nervous tissue having specialized cells called neurons or nerve cells to respond to stimuli and coordinate animal's activities.

Nerve cells or neurons are, in fact, the structural and functional units of nervous system. In higher multicellular animals, the nervous tissue consists of nerve cells of neurons, nerve fibres, bundle of nerve fibres forming nerves, packing cells (neuroglia), ependymal cells and neurosecretory cells.

Arrangement Of Neurons

The neurons lie end-to-end in chains to transmit nerve impulses in the animal body. Each neuron receives an impulse through its dendrites and passes it on to to the next neuron in the chain through its axon via cell body.

Synapse: The neurons are not connected. There occurs a very minute gap between terminal portion of axon of one neuron and the Dendron of other neuron. This minute gap is called synapse. Synapse is thus the functional junction between neurons. At the synapse, axon terminal comes in close proximity to the dendron terminal of next neuron. Axon terminal is expanded to from presynaptic knob. On the other hand, the dendrite terminal forms post-synaptic depression. In between the two, lies a narrow fluid filled space called synaptic cleft.

As the nerve impulse reaches the presynaptic knob, the synaptic vesicles get stimulated to release a chemical called neurotransmitter in the synaptic cleft. The neurotransmitter molecules diffuse across the gap (synapse) to come in contact with the chemoreceptor sites in the post-synaptic membrane. In this way, nerve impulse passes across the minute gap (synapse) to stimulate dendron of other neuron.

The synapse acts as a one-way valve to conduct nerve impulse in one direction only. This is so because chemical substance, called neurotransmitter, is secreted by synaptic vesicles only on one side of the gap, i.e. on axon's side. The neurotransmitter carries message across the synapse and passes it to the dendron of the other neuron.

In this way, impulses travel across the neurons only in one direction, i.e. from axon of one neuron to dendron of other neuron through a synapse.

Define:-

Nerve Impulse:-

It is a self propagated electrochemical current that travels from one neuron to another neuron for the passage of message.

Receptor:- It is a nerve cell or group of nerve cells which is sensitive to a specific stimulus or to specific change in the environment.

Effector:- It is a muscle or gland in specific part of the body which produces suitable response.

Types Of Neurons

The neurons are of three types:

i) Sensory (receptor) neurons, ii) motor (effector) neurons and (iii) relaying (connector) neurons.

i) **Sensory (Receptor) Neurons:-** These often occur in sense organs and receive stimuli by their dendrites. The sensory neurons transmit impulses towards the central nervous system (brain and spinal cord) through their axons.

ii) **Motor (Effector) Neurons:-** The dendrites of these neurons synapse with axons of sensory neurons in central nervous system. They transmit impulses from central nervous system towards effectors (muscles or glands). The latter respond to stimuli.

iii) **Relaying (connector) Neurons:** Thse occur in the central nervous system (brain and spinal cord). These serve as links between sensory and motor neurons for distant transmission of nerve impulses.

Sensory Receptors:-

It is a cell or group of cells specialized to detect a particular stimulus and to initiate the transmission of impulses via. The sensory nerves.

There are five receptors or sense organs through whicvh the animals receive stimuli or external informations. These receptors are phonoreceptors for sound (ears), gustatory receptors for taste (tongue), olfactoreceptors for smell (nose) and thigmoreceptors for touch (skin). The receptors pass information to the brain. The brain transmits motor impulses to appropriate effectors which produce suitable responses.

Structure of neuron:

Neuron is the structural and functional unit of nervous system. It has a special structure to receive, conduct and transmit impulses. It varies greatly in shape and size. A neuron consists of three prominent parts: i)Cell body ii) Dendrites iii) Axon

i) **Cell body:-** The cell body of a neuron is called as cyton or soma. This cyton is broad, rounded, pyriform or stellate part of neuron. It has abundant cytoplasm called neuroplasm and a relatively large, speherical nucleus. The cytoplasm has mitochondria, golgi apparatus, neurofibrils, neurotubules and special granules called Nissl's granules or Tigroid body. Nissl granules were discovered by a German neurologist Franz Nissl. They are formed by the combination of ribosomes with rough endoplasmic reticulum and are meant for the synthesis of neurotransmitter (acetyl choline)

Centrioles are absent in neurons. Cell body is concerned with metabolic maintenance and growth. It also receives nerve impulses from dendrites and transmits them to axam.

ii) **Dendrites (singular Dendron):-** These are several short, tapering, much branched protoplasmic processes stretching out from the cell body of a neuron. Dendrites are the part of neuron where sensation is acquired. The information then travels as an electric impulse towards the cell body. Dendrites contain Nissl's granules and neurofibrils.

iii) **Axon:-** It is single, long, cylindrical protoplasmic process of uniform diameter arising from cell body. At its terminal end, it is highly branched and the terminal branches are called terminal arborization. At the ends of terminal arborization, are swollen structures called synaptic knobs that have a neurotransmitter called acetyl choline in them. Acytyl choline diffuses out at the time of conduction of nerve impulse.

Axon is covered with one or two sheaths. Sheathed axon is termed as nerve fibre. The cell membrane of the axon is called axolemma and its cytoplasm is termed axoplasm. It lacks Nissl's granules. However, neurofibrils are present. The single sheath present over the axon is made of Schwann cells and is called neurilemma. The axon may have an additional insulating and protective sheath of myelin around it. It is present between neurilemma and axon. Axons having myelin sheath are termed myelinated fibres and those without this sheath are termed non myelinated nerve fibres. At intervals, myelinated nerve fibres possess unmyelinated areas called nodes of Ranvier.

Characteristics of neurons:

i) They do not divide.
ii) They are formed shortly after birth.
iii) They are not repaired, when injured.
iv) They use only glucose as a respiratory substrate.
v) They die, if deprived of oxygen for over 5 minutes.

Functions of neurons:

The information acquired at the end of the dendritic tip of a neuron sets off a chemical reaction which creates an electrical impulse. The impulse travels from the dendrite along the axon of its end. At the end of axon, the electrical impulse sets off the release of some chemical, which cross the synapse and start a similar impulse in the dendrite of next neuron. In this way, nerve impulses travel in the body. Thus, nervous tissue is made up of an organized network of neurons which are specialized for conducting information via electrical impulse from one part of body to another.

Reflex Actions, Involuntary And Voluntary Actions

Animals perform three types of actions. These actions are:

- Reflex actions.
- Involuntary actions.
- Voluntary actions

Reflex actions:- Reflex action was discovered by Marshal Hall (1833). A reflex action may be defined as a spontaneous, unconscious automatic and mechanical response to a stimulus, acting on a specific receptor, without the will of an animal.

Need for Reflex Action:- The receptors, present on various body parts, receive stimuli and transmit information in the form of nerve impulses to the central nervous system which has various coordination centres where the information is processed. The processing is done on the basis of information and experiences already stored. The message is then sent by coordination centres through motor neurons to appropriate regions of the body which accordingly respond and react. The whole process takes some

time. However in certain situations, sensation requires immediate response as time used for processing may cause harm to the body. In such situations, reflex actions occur.

Examples. Blinking of eyes, movement of diaphragm during respiration, coughing, yawning, sneezing etc.

What Happens in Reflex Actions?

In reflex action, fine tips (dendrites) of receptors (sensory neurons) quickly relay a message (electric impulse) via sensory nerves to the spinal cord. The spinal cord then sends information (impulse) via motor nerves to effectors (muscles or glands) which show response. The path taken by nerve impulses in a reflex action is called reflex arc.

Reflex Arc: The path taken by nerve impulse in a reflex action is called reflex arc. It consists of five parts:

i) **Receptor**: It is a specific group of cells or organ, the neurons of which receives a stimulus and set up a sensory impulse.

ii) **Sensory (Afferent) Nerve:-** It carries sensory impulse from the receptor to the central nervous system.

iii) **A Portion of Central Nervous System:-** It is spinal cord or brain. Its neurons analyse and interpret the sensory impulse and set up an appropriate motor impulse. Accordingly, reflexes are termed spinal reflexes or cerebral reflexes.

iv) **Motor (efferent) Nerve:-** It carries motor impulse from the central nervous system to specific effectors (muscle fibres or gland cells).

v) **Effector:** It may be muscle fibres or gland cells. Here, impulse terminates and response occurs as per instructions received from central nervous system.

For example when our hand accidently touches a hot object, the heat is sensed by thermo receptors present in the skin of hand. The stimulus triggers nerve impulse in sensory (receptor) neuron. It transmits message to the spinal cord. In the spinal cord, impulse is passed on to the relay (connector) neuron which, in turn, passes it to the motor neuron. The motor neuron transmits the instruction to a muscle in our arm. The arm muscle contracts and pulls our hand away from the hot object. Such reflexes which involve spinal cord are also termed spinal reflexes.

Significance of Reflex Action

1. It checks overloading and overtaxing of brain.
2. It results in quick response to otherwise harmful stimuli without the processing done by coordinating centres of central nervous system.
3. It has survival value.

Involuntary Actions

Involuntary muscular actions are performed by the animal without its will. These occur automatically and the animal has no choice in it. Such actions are meant for controlling and coordinating the functioning of internal organs. Many of these involuntary actions are controlled by the midbrain and hind brain. Regular breathing of heart, blood pressure, movements of diaphragm during normal respiration, peristaltic movements in the oesophagus, salivation, vomiting, movement of the internal viscera etc. are all involuntary actions and are controlled by hind brain.

Voluntary Actions

Voluntary muscular actions are performed by the animal with its will. In each voluntary action, the animal exercises its choice so that the same stimulus may receive different responses at different times depending upon the situation. For instance, on seeing a snake in the way, one may run away on first occasion or call for help on second occasion or try to kill it to save himself on the third occasion. All such actions are voluntary actions that are controlled by cerebellum part of hind brain. Similarly, walking in a straight line, riding a bicycle, picking up a pencil are also voluntary actions controlled by cerebellum.

How Does the Nervous Tissue Cause Action?

The terminal part of axon of motor neuron synapses with the membrane of the muscle (motor end plate). When the nerve impulse from CNS reaches the muscle, the muscle fibres show movement. The muscle fibres, in fact, have special proteins that change their shape and their arrangement in response to nerve impulses. New arrangement of these proteins gives the muscle different shapes.

Human Nervous System

Human nervous system is the most complex. It is divided into two main parts:

i) Central nervous system
ii) Peripheral nervous system

i) **Central Nervous System (CNS):-** It is hollow and lies on the mid dorsal part along the main (longitudinal) axis of the body. It is covered externally by part of axial skeleton. The CNS, in turn, consists of two parts:
   a) Brain or encephalon situated in the head.
   b) Spinal cord or myelon located in the neck and trunk.

a) **Brain (Encephalon):-** The brain is the widest and the uppermost part of the central nervous system. It is the highest coordinating centre in the body. Brain is situated in the cranial cavity of the skull in the head region of the body. The bones of cranium or brain box protect this delicate organ from mechanical injury. The brain is contained in a fluid-filled balloon which provides further shock absorption. The study of brain in all aspects is called encephalogy.

Morphology:-

The brain is soft, whitish organ. It weighs 1.2–1.4kg and forms about 98% of the weight of the whole central nervous system. It has about 100 billion neurons (nerve cells). Brain is surrounded by three membranes called meninges which provide protection to it. The space between these three meninges is filled with cerebro-spinal fluid which protects the brain from mechanical shocks. The cell body of the neurons constitutes the grey matter and the fibres constitute the white matter of brain. Both the brain and spinal cord have white matter (bundles of axons having myelin sheaths) and grey matter (masses of the cell bodies and dendrites).

Brain is divisible into three main regions:

1. Forebrain
2. Midbrain, and
3. Hind brain

1. **Forebrain (Prosencephalon):-** It forms the greater part of the brain. It further consists of three regions: olfactory lobes, cerebral hemispheres (cerebrum) and diencephalon.
   i) **Olfactory lobes:** - These are a pair of widely separated club-shaped small structures. These are fully covered by the cerebral hemispheres and are, thus, visible only in the ventral view of the brain. Each olfactory lobe consists of an anterior olfactory bulb and a posterior narrow olfactory stalk. These lobes receive impulses from olfactoreceptors (present in the olfactory epithelium in the nose) and relay sense of smell to the temporal region of the cerebrum.
   ii) **Cerebral hemispheres (cerebrum):- It** forms the largest part of the brain. It is also the most complex and specialized part of the brain. The two cerebral hemispheres lie side by side, being separated from each other by a deep longitudinal cerebral fissure. The surface of these cerebral hemispheres is greatly folded to accommodate large number of nerve cells. The folds are called gyri (singular gyrus) and the depressions between them are termed sulci (singular sulcus). Each cerebral hemisphere is divided by three deep fissures into four lobes: anterior frontal lobe, middle parietal lobe, posterior occipital lobe and lateral temporal lobe. Different areas of cerebrum have different functions. For instance, it has sensory areas which receive impulses from the sense organs or sensory receptors, e.g. eyes, ears, tongue, nose and skin. Similarly, cerebrum also has motor areas which send instructions in the form of impulses to various effectors of the body (e.g. muscles). The latter then respond to stimuli. There are specific regions in cerebrum for each kind of stimulus and its response. For instance-
      - Frontal lobe is the region of speech, facial muscular activities as well as higher mental activities.
      - Temporal lobe is the region for auditory reception (hearing).
      - Occipital lobe is the region for visual reception (sight).
      - Parietal lobe is the region for touch, taste, smell, temperature and conscious association.

      Each lobe also has some areas called association areas which store information and experiences. These association areas control thinking, memory, learning and emotions. Internally, each cerebral hemisphere possesses a fluid-filled cavity called lateral ventricle.
   iii) **Diencephalon:-** It lies on the inferior side of the cerebrum and thus is visible in the ventral view of the brain. Its roof is called epithalamus, sides are called thalami and its floor is termed hypothalamus, Diencephalon has a narrow cavity called third ventricle. Hypophysis (pituitary) is attached by a stalk or infundibulum to the hypothalamus region. Hypothalamus has control centres for hunger, thirst, fatigue, sleep, body temperature, sweating and emotions. It secretes neurohormones which regulate the secretions of pituitary.
2. **Mid brain (Mesencephalon):-** It is significantly small region. It consists of two fibre tracts called crura cerebri and two swellings called superior and inferior colliculi on each side. The fibrous tracts, i.e., crura cerebri connect hind brain with the fore brain. The four swellings of both sides are together known as corpora quadrigemina. The

two superior colliculi have centres for sight reflexes while the two inferior colliculi have centres for auditory reflexes.

The mid brain controls reflex movements of:

i) The head, neck and trunk in response to visual and auditory stimuli, and

ii) The eye muscles; changes in pupil size as well as shape of the eye lens.

3. **Hind brain (Rhombencephalon):-** The hind brain consists of three parts:- cerebellum, pons varolii and medulla oblongata. The cerebellum is the second largest part of the brain, constituting nearly 12.5% of it. It has two large, lateral cerebellar hemispheres and a central vermis. Cerebellum maintains the posture, equilibrium and muscle tone. Pons varolii controls some aspects of respiration. Medulla oblongata is the posterior most part of the brain which lies below the cerebellum. It continues posteriorly into the spinal cord. It contains a fluid-filled cavity called fourth ventricle. Medulla oblongata controls (i) rate of heart beat, (ii) breathing movements, (iii) expansion and contraction of blood vessels to regulate blood pressure, and (iv) swallowing, coughing, sneezing and vomiting.
Twelve pairs of cranial nerves arise from the brain.

Functions of brain:

i) It receives information by carrying impulses from all the sensory organs of the body.

ii) It response to the impulses brought in by sensory organs by sending its own instructions to the muscles and glands causing them to function accordingly.

iii) It correlates the various stimuli from different sense organs and produces the most appropriate and intelligent response.

iv) It coordinates the bodily activites so that the mechanisms and chemical reactions of the body work together efficiently.

v) It stores information so that behavior can be modified according to the past experience. This function makes the brain the organ of thought and intelligence.

2. **Spinal Cord:** Spinal cord is a cylindrical structure and is about 45cm long. It begins in continuation with the medulla oblongata of brain and extends downwards upto early part of lumber region. It then extends to the end of vertebral column as fibrous connective called filum terminale. Internally, the spinal cord possesses a narrow, fluid-filled cavity called central canal. Spinal cord is enclosed in the vertebral column or backbone which protects it. Like brain, spinal cord too is surrounded by meninges. Thirty one pairs of spinal nerves arise form the spinal cord. Spinal cord performs two important functions:

i) It conducts sensory and motor impulses to and from the brain.

ii) It acts as a centre for the reflex actions. Thus, it reduces brain's work.

Peripheral Nervous System

It connects CNS with different parts of the body. It has two components, voluntary and involuntary.

Voluntary peripheral nervous system is under the control of will. It consists of nerves that arise directly from CNS connecting different body parts for voluntary (conscious) control of the brain.

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Involuntary peripheral nervous system (autonomic nervous system), on the other hand, is not under the control of human will. It develops from branches of some cranial and spinal nerves called visceral nerves.

Peripheral nervous system, thus, consists of all the three types of nerves namely,

i) Cranial nerves ii) Spinal nerves (iii) Visceral nerves

i) **Cranial nerves:-** Cranial nerves arise from the brain and spread to various parts of the head. They are 12 pairs in number. Cranial nerves I, II and VIII are sensory nerves; cranial nerves III, IV, VI, XI and XII are motor nerves; and cranial nerves V,VII, IX and X are mixed nerves (containing both sensory and motor nerve fibres).

ii) **Spinal nerves**:- Thirty one pairs of spinal nerves arise from the spnal cord along most of its length and spread throughout the body (except head region). They are all mixed nerves as they carry both sensory and motor nerve fibres.

iii) **Visceral nerves:-** Apart from regulating normal functions of the body, many activities of the internal organs such as heart, kidney, lungs , urinary bladder, blood vessels, glands etc. are controlled by specific set of nerves called visceral nerves which mostly arise from spinal cord but a few from the brain also. These form the autonomic nervous system.

Autonomic Nervous System:

It is the system which operates automatically or involuntary. It includes of those responses against stimuli which are not under the control of animal. Visceral nerves of autonomic nervous system control the activities of internal organs. So it is also termed as visceral nervous system.

Autonomic nervous system is subdivided into two parts:

i) Sympathetic nervous system ii) Parasympathetic nervous system

Protective coverings:

Both brain and spinal cord are protected from mechanic injury and shock by bony cases around them. Brain is protected by cranium (brain box) while spinal cord is protected by vertebral column. There are also present additional protective coverings called meninges between the brian or spinal cord and their respective bony cases. These meninges are three in number namely duramater, piamater and arachnoid. The space between the meninges is filled by a fluid called cerebrospinal fluid

Cerebrospinal fluid:-

it is a clear , colourless slightly alkaline fluid present in the ventricles of the brain, spinal cord and spaces between meninges. It protects the CNS from shocks and keeps its moist. It also carries wastes, drugs and other harmful substances from brain to the blood. It also maintains a constant pressure inside the cranium inspite of variations in the pressure of blood in the cranial vessels.

Chemical Coordination In Animals

In animals, the message, communicated in the form of nerve impulses, from receptors (sensory neurons) to central nervous system and from latter to the effectors (muscles and glands) is very quick. The nervous coordination in animals, however, has certain limitations. For instance,

- Nerve impulses can reach to only those animal cells which are connected by nervous tissue, and
- Such cells, after generation and transmission of nerve impulses, take some time to reset their mechanisms before a new impulse is generated and transmitted.

Hormones

The word hormone was introduced by William M. Bayles and Earniest N. Starling. It has been derived from the Greek work harmein which means to excite because it is responsible for excitement or disturbance in our body. These are secreted by special cells called endocrine cells. Hormones, therefore, are chemical substances secreted in trace amounts by endocrine glands and are means of information transmission.

Transport And Recognition Of Hormones

The cells of endocrine glands secrete chemical substances. When they receives stimulus they pour these secretions in blood which then goes to each and every organ but only target organ shows response because in target organ special sites called receptors are present and a particular hormone gets binded with it and the message present in hormones gets transmitted to receptor. The shape of receptor gets changed because it receives new information due to which new responses get produced.

Difference between nervous and hormonal information

	Nervous information	Hormonal information
1	It is sent as an electrical impulse along axons, and as a chemical across synapse.	It is sent as a chemical messenger via blood stream.
2	Information travels rapidly, in milliseconds.	Information travels slowly.
3	Information is directed to specific receptors-one of a few nerve fibres, gland cells or other neurons, i.e., it is addressed by name.	Information is spread throughout the body by blood from which the target cells or organs pick it up, i.e., it is addressed to 'whom it may concern'.
4	It gets response immediately.	It gets response usually slowly.
5	Its effects are short-lived.	Its effects are generally more prolonged.

Characteristics of hormones

The hormones in animals show following characteristic features:

i) They are synthesized by endocrine glands.

ii) They are produced at a place other than the site of action. They travel through blood to other parts where they cause changes.

iii) They are secreted directly into the blood stream.

iv) They act on specific tissues or organs. The tissues or organs that respond to the hormones are called as target organs.

v) They are secreted in response to changes in the external or the internal environment of the body and are also called as chemical messengers.

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vi) They may stimulate or inhibit the activity of the target organ, thus regulating its activity.

vii) They are effective in minute quantities, often in trace amounts difficult to detect at times.

viii) Excess or deficiency of a hormone may lead to serious consequences.

Glands and its types:

Gland: It can be the cell or tissue or organ which secretes certain useful substances for the proper functioning of body.

There are three types of glands in animals.

i) **Exocrine glands:-** These are those glands which directly pour the secretions into the duct and these ducts carry them to target organs. These are also called duct glands for example salivary glands, gastric glands, etc.

ii) **Endocrine glands:-** It has been derived from Greek word 'endon' which means within and 'Krinein' which means to secrete. These are those glands which directly pour their secretions into blood and are called ductless glands or are also known as glands of internal secretion. There secretions of endocrine glands are called hormones or internal secretion for example pituitary glands, thyroid glands, parathyroid gland etc.

iii) **Heterocrine glands:-** These glands consist of both exocrine and endocrine glands. A part of Heterocrine gland act as exocrine gland and a part of it acts as endocrine gland. For example pancreas and gonads. A part of pancreas acts as endocrine gland and secretes insulin and glycogen and a part of it acts as exocrine gland and secretes pancreatic juice. Another example is of ovaries in females. Its endocrine part secretes estrogen and progesterone and its exocrine part produces ova. Another example is testes in males. Its endocrine part secretes testosterone and its exocrine part produces sperms.

Human endocrine glands

The major endocrine glands, their secretions, principal functions of the various hormones secreted by them are:-

1. **Hypothalamus :-** It is situated at the base of the brain and is composed of nervous tissue. The neurosecretary cells of the hypothalamus secrete several neurohormones called Releasing Hormones (RH) and Inhibiting Factors or Hormones (IF or IH). These neurohormones are carried to the pituitary gland to stimulate or inhibit the secretion of anterior pituitary hormones. Hypothalamus also secrets two neurohormones oxytocin and vasopressin (also called antidiuretic hormone or ADH). These are subsequently stored in posterior lobe of pituitary.

2. **Pituitary gland:-** It is small, red, grey in colour and is pea shaped and pea sized. It is located below brain and is attached to hypothalamus by means of stalk called infundibulum. It has three lobes:-

a. **Anterior lobe:-** It produces six hormones.

i) Growth hormone (GH) or Somatotrophic hormone (STH)

Functions:
It controls the overall development or growth of body, muscles, bones and tissues.

ii) Thyroid stimulated hormone (TSH):-

Functions:
It controls the growth and functioning of thyroid gland. It also stimulates the thyroid gland to produce thyroxine.

iii) Adrenocorticotrophic hormone (ACTH)

Functions:
It stimulates the adrenal cortex to secrete its hormones.

iv) Follicle stimulating hormone (FSH)

Functions:
In males, it stimulates the process of spermatogenesis (sperm formation). In females, it stimulates the follicle cells in the ovaries to develop into mature eggs and also stimulates them to produce oestrogen.

v) Luteinising hormone (LH) (FSH and LH are together called gonadotrophins)

Functions:
In males, it stimulates the secretion of male hormone, testosterone (sex hormone in males). In females, it stimulates the secretion of oestrogen and progresterone (sex hormones in females).

vi) Prolactin hormone (PRL)

Functions:
It enhances mammary glands development and milk production in females.

b. Intermediate lobe: It secretes melanocyte stimulating hormone (MSH)

Functions:
It stimulates the synthesis of melanin in the skin.

c. Posterior lobe: It secretes

i) Oxytocin

Functions:
It stimulates contraction of smooth muscles at the time of child birth. It also helps in milk ejection (lactation) from the mammary glands.

ii) Vasopressin or Antidiuretic hormone (ADH)

Functions:
It regulates water and electrolyte balance in body fluids.

3. Pineal gland:- It lies between the two cerebral hemispheres of the brain. It secretes melatonin.

Functions:
It regulates the working of gonads.

4. Thyroid gland

- It is situated in the neck region on the ventral side of the body. It has two lateral lobes, one on either side of the trachea.

a) Thyroxine or T4 and tri iodothyronine or T3.

Functions:

T3 and T4 stimulates the rate of cellular oxidation and metabolism.

b) Calcitonin:-

Functions:

Calcitonin lowers calcium level when by suppressing release of calcium ions from the bones, calcium level is high in blood.

5. Parathyroid gland:

- These are four small oval bodies which lie embedded in the lobes of the thyroid gland. It secretes parathyroid hormone (PTH) or parathormone.

Functions:

It regulates calcium and phosphate levels in the blood. When blood calcium level is below normal, it mobilizes the release of calcium into the blood from bones. It has an action opposite to that of calcitonin on calcium metabolism.

6. Thymus gland:

- It is situated in the upper chest near the frond side of heart.. It secretes thymosin.

Function:

It stimulates the development and differentiation of lymphocytes.

7. **Adrenal gland:-** In human being, a pair of adrenal glands are present, one on top of each kidney, so are also called as suprarenals . Each adrenal gland has an outer part called the cortex and an inner part medulla.

   i) Adrenal cortex: It secretes three groups of hormones.

   - Glucocorticoids:- It regulates the metabolism of proteins, fats and carbohydrates in the body and the level of blood sugar. It regulates heart beat and blood pressure.
   - Mineralocorticoids (Aldosterone):- It regulates water and mineral balance in the body.
   - Sex corticoids:- It stimulates the development of secondary sexual characters both in males and females.

   ii) Adernal Medulla :- It secretes two hormones.

- Adrenaline (Epinephrine) and Non-adrenaline (Non-epinephrine)

Functions:

Both these hormones together control emotions , fear, anger, blood pressure , heart beat, respiration and relaxation of smooth muscles.

8. **Pancreas:** It is a heterocrine gland and is located in the abdominal region. Its endocrine part is islets of langerhans which secretes two hormones.

- Insulin:- It regulates the conversion of glucose to glycogen i.e. it lowers blood glucose level.

- Glucagon:- It regulates the conversion of glycogen back to glucose i.e. it increases blood glucose level.

9. **Ovaries:-** These are the pair of organs present in lower abdominal region in females. It secretes two hormones:-

- **Progesterone and estrogen:** - These play an important role in ovulation. These help in the preparation of uterus for the reception of fertilized ovum.
  These hormones also help in the maintenance of pregnancy.
  Oesotrogens are responsible for development of secondary sexual characteristics in females like mammary gland, voice, hair pattern, etc.

10. **Testes:** These are extra abdominal in position. The interstitial or Leydig cells present in testes produce male hormone. It secretes one hormone.

Testosterone:- It regulates the growth, development and functioning of accessory sex organs and controls the secondary sexual characteristics in males.

Disorders of endocrine gland

Disorders of pituitary

i) Dwarfism: Dwarfism is caused due to deficiency of growth hormone from early age.

ii) Gigantism:- It is giant size of the youngs with very tall skeleton and proportionally large muscles and viscera. It is caused due to excess secretion of growth hormone from childhood.

iii) Acromegaly: It is caused due to excess secretion of growth hormone after adolescence. Acromegaly in adults leads to overgrowth of the jaw bones and bowing of the spine (backbone)

iv) Diabetes insipidus: Deficiency of ADH reduces reabsorption of water and increases urine
output, causing excessive thirst. This disorder is called diabetes insipidus. No glucose is lost in the urine of such a patient.

Improper secretion of thyroid hormones

i) Grave's disease (exophthalmic goiter): It is caused by hypersecretion (oversecretion) of thyroid hormones due to enlargement of thyroid gland. Excess of thyroid hormones increases metabolic rate and accelerates oxidation. This results in quick consumption of food, leaving nothing for storage and causing emaciation (excessive leanness).

ii) **Simple goiter (iodine deficiency goiter or endemic goiter)**: It is the enlargement of thyroid gland accompanied with cretinism or myxoedema. Its caused due to dietry deficiency of iodine. This disease is common in hilly areas. It causes enlargement of thyroid gland. Swollen neck is one of the symptoms of this disorder. Addition of iodides to the table salt prevents the disorder. In our country, common salt is iodized to provide required iodine to the thyroid gland.

iii) **Myxoedema:-** It is caused by deficiency of thyroid hormones in adults. It is more common in women than in men.

iv) **Cretinism:-** Hypothyroidism (Hypo activity of thyroid gland) causes cretinism in young children. Its symptoms are stunted growth, short club-like fingers , deformed bones and teeth. Skin is rough, dry and wrinkled with scanty hair growth. Pot –bellied abdomen. Idiocy of varying degree is observed.

Deficiency of insulin:

Diabetes mellitus: Deficiency of insulin hormone in the body causing a disease known as diabetes mellitus. In this disease, the patient excretes sugar (glucose) in urine, feels excessive thirst and also does excessive urination.

Q How are involuntary action and reflex action different from each other?

Ans. Involuntary action:

i) Involuntary action involves autonomic nervous system.
ii) They occur in response to internal stimuli.
iii) They are connected with functioning of internal body parts.
iv) It occurs without the will of the organism. For example, heart beat, breathing, etc.
v) These are regulated by medulla oblongata (hind brain).

Reflex action

i) Reflex action involves all parts of voluntary nervous system though they are not voluntary.
ii) They operate against harmful stimuli which are generally external.
iii) Some reflexes involve the brain, rather than the spinal cord.
iv) Reflex is generally controlled by spinal cord.
v) They are connected with emergency i.e. response to stimuli.

Textual Questions

Q#1 What is the difference between a reflex action and walking?

Ans. Reflex action is a immediate response of the spinal cord to a sudden impulse. It is conducted by the spinal cord. But walking is a voluntary action which is controlled by cerebellum part of hind brain.

Q#2 What happens at the synapse between two neurons?

Ans. Synapse is the gap between the nerve endings of one neuron and dendrites of another neuron. At synapse, the electrical impulse generated at dendrites of a neuron is passed on the dendrite of another neuron in the form of chemicals by axon ending of the first neuron. Synapse also ensures that nerve impulse travels only in one direction.

Q#3 Which part of the brain maintains the posture and equilibrium of the body?

Ans. Cerebellum part of the hind brain maintain the posture and equilibrium of the body.

Q#4 How do we detect the smell of an agarbatti (incense stick)?

Ans. Smell of an incense stick is detected by the olfactory receptors located in the forebrain.

Q#5 What is the role of the brain in reflex action?

Ans. Reflex actions generally involve spinal cord for quick response to specific stimulus. However, the information input also goes on to reach the brain where thinking process occurs.

Q#6 What are plant hormones?

Ans. Refer to note on plant hormones.

Q#7 How is the movement of leaves of a sensitive plant different from the movement of the shoot towards light?

Ans. The movement of leaves of a sensitive plant is neither towards nor away from stimulus like touch. While movement of shoot is towards stimulus like light. The movement of leaves of sensitive plant is non directional while the movement of shoot is directional.

Q#8 Give an example of a plant hormone that promotes growth.

Ans. Auxin is the plant hormone that helps in cell elongation and growth.

Q#9 How do auxins promote the growth of a tendril around a support?

Ans. The movement of tendril around the support is caused by the auxins hormones. Less auxins occurs on the side of contact as compared to the free side. As a result, auxins promotes the growth on the free side and the tendril coils around the support.

Q#10 Design an experiment to demonstrate hydrotropism.

Ans. Experiment to Demonstrate Hydrotropism:

1) Take a wire mesh and cover it with moist saw dust.
2) Place some germinated seedling (pea or gram) on the moist saw dust.
3) Keep the saw dust moist by sprinkling water at regular intervals. Observe after 2-3 days.
4) As the radicals come out of seeds, they are seen to move towards the perforation. After some growth they bend back and enter the perforations to reach the moist saw dust in complete disregard of gravity (positive hydrotropism).

Q#11 How does chemical coordination take place in animals?

Ans. In animals chemical coordination is achieved through the agency of hormones which function as chemical messengers or informational molecules. Hormones are secreted in a very small amount by specialized tissues in the body called endocrine glands. In fact endocrine glands are often called ductless glands, because hormones are secreted directly into the blood without the involvement of any special duct. Hormones coordinate the activities of living organisms and also their growth. They affect only particular tissues called target tissues. These organs and tissues then responses and enabled the body to deal with different situations. For example, pancreas secretes two hormones, insulin and glucagon. The function of insulin hormone is to lower the blood glucose. Deficiency of insulin hormones in the body causes a disease known as diabetes. The function of glucagons hormone is to increase the blood glucose.

Q#12 Why is the use of iodised salt advised?

Ans. Iodine is essential for the synthesis of thyroxine hormone in the thyroid gland. Thyroxin regulates carbohydrates, protein and fat metabolism in the body so as to provide the best balance for growth.

In case of deficiency of iodine in our diet, there is a possibility that we suffer from goitre. Iodised salt contains proper content of iodine. Thus, to avoid deficiency of iodine, iodised salt is recommended.

Q#13 How does our body respond when adrenaline is secreted into the blood?

Ans. Adrenaline hormone is secreted in small amounts all the time, but in large amounts when a person is frightened or mentally disturbed. When adrenaline is secreted in large amounts it prepares our body for action. It increases the rate of heartbeat and breathing, raises blood pressure and allows more glucose to go into the blood to give us a lot of energy quickly to fight or runaway from the frightening situation or to deal with the emergency situations.

Q#14 Why are some patients of diabetes treated by giving infections of insulin?

Ans. Diabetes (Diabetes mellitus) is caused due to less or no secretion of hormone insulin by pancreas. In such a person, blood sugar level is high. Insulin converts extra sugar present in blood into glycogen. Thus, patients suffering from diabetes (Diabetes mellitus) are given insulin infections to control their blood sugar level.

Q#15 What is the function of receptors in our body? Think of situations where receptors do not work properly. What problems are likely to arise?

Ans. The receptors in our body collect information about changes in the environment around us in the form of stimuli, e.g., photoreceptors, gustoreceptors, thermoreceptors, statoreceptors, tangroreceptors. These

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then pass the information in the form of nerve impulse to the central nervous system (spinal cord and / or brain) where the message is interpreted and appropriate instructions are sent to effectors (glands or muscles) which reveals responses. When receptors do not function normally, the environmental stimuli are not able to create nerve impulses and the body does not respond.

Q#16 Draw the structure of neuron and explain its function.

Ans. Refer to notes.

Q#17 How does phototropism occur in plants?

Ans. Photo tropism is a directional growth movement which occurs in response to unidirectional exposure to light. Phototropic movement is generally caused by increased ausin concentration on the dark side and less auxin concentration on the illuminated side. Due to the presence of more auxin, the part of the plant in the dark grows faster,causing it to bend towards the source of light.

Q#18 Which signals will get disrupted in case of spinal cord injury?

Ans. In case of spinal injury, reflex actions and involuntary actions will get disrupted.

Q#19 How does chemical coordination occur in plants?

Ans. In plants, chemical coordination occurs with the help of plant hormones (phytohormones). Amount of hormones depends upon the environment and other stimuli. Different plant hormones help to coordinate growth, development and responses to the environment. They are synthesized at places away from where they act and simply diffuse to the area of action, for example, auxin which promotes cell differentiation. Another example of plant hormones are gibberellins which help in the growth of the stem. Cytokinins promote cell division. Abscisic acid is a plant hormone which inhibits growth and its effects include wilting of leaves.

Q#20 What is the need for a system of control and coordination in an organism?

Ans. The body of a multicellular organism consists of a number of components and sub-components and each specialized to perform a particular function. Therefore, it is necessary that various organs of the body of an organism work together in a proper manner to produce proper response to a stimulus. In human being, nervous system and endocrine system work together for control and coordination.

Q#21 How are involuntary action and reflex action different from each other?

Ans.

Sr.No.	Involuntary Action	Reflex Action
1.	They involve autonomic nervous system.	They involve all parts of voluntary nervous system though they are not voluntary.
2.	They occur in response to internal stimuli.	They operate against harmful stimuli which are generally external.
3.	They are connected with functioning of the internal body parts.	They are connected with emergency.
4.	Involuntary actions occur without the will of the animal. For example, heartbeat, breathing, etc.	Some reflexes involve the brain, rather than the spinal cord.
5.	These are regulated by medulla for hind brain.	Reflex actions are generally controlled by spinal cord.

Q#22 Compare and contrast nervous and hormonal mechanism for control and coordination in animals.

Ans. Refer to notes.

Q#23 What is the difference between the manner in which movement takes place in a sensitive plant and the movement in our legs?

Ans. The differences between movement in a sensitive plant and the movement in our legs are:

Movement in a sensitive plant	Movement in legs
1. It occurs in response to an external stimulus like touch, pressure or shock. 2. It is brought about by turgor changes in specific cells. 3. It is controlled by plant hormones.	1. It occurs voluntarily in response to our need and will. 2. It is brought about by contraction and relaxation of muscles. 3. It is controlled by cerebellum of the hind brain.

Q#24 Multiple Choice Questions:

i) Which of the following is a plant hormone?

a) Insulin b) thyroxine
c) oestrogen d) cytokinin

Ans. Cytokinin.

ii) The gap between two neurons is called a

a) dendrites b) synapse
c) axon d) impulse

Ans. Synapse

iii) The brain is responsible for

a) Thinking b) regulating the heart beat
c) Balancing the body d) all of these

Ans. All of these

Q#25 Which hormone is released into the blood when its sugar level rises? Name the organ which produces the hormone and its effect on blood sugar level. Also name one digestive enzyme that this organ secretes and the function of this enzyme.

Ans. Insulin hormone is released into the blood when its sugar level rises. Pancreas secretes the insulin hormone. The function of insulin hormone is to lower the blood sugar level. Deficiency of insulin hormone in the body causes a disease known as diabetes. Diabetes is characterized by large quantities of sugar in the blood. The insulin hormone controls the metabolism of sugar. If due to some reason, pancreas does not produce and secrete sufficient amount of insulin into blood, then the sugar level in the blood rises. The high sugar level in the blood can cause many harmful effects to the body of person. The people having severe diabetes are treated by giving injection of insulin.

The pancreas secretes pancreatic juice which contains enzymes like trypsin for digesting proteins, lipase for breakdown of emulsified fats and amylase for breakdown of starch.

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Reproduction:-

Is a process by which a living organism is able to produce more of its own kind. Reproduction is an energy spending process which is not at all essential to maintain the life of an individual organism. Even then, the organisms reproduce. The process of reproduction is essential for the existence and continuity of a species. The continuity of life on earth, from its origin to the present day, has been possible only because of reproduction.

Do Organisms Create Exact Copies Of Themselves?

- In asexual reproduction, a new individual develops directly from specialized or unspecialized parts of a single parent without involving fusion of sex cells (gametes). Therefore, offsprings resulting from the asexual reproduction are exactly identical to the parent except in size and are called clones. Each individual of a clone is called ramet.
- In sexual reproduction, first haploid (n) gametes are produced by meiotic division, then fusion of gametes takes place leading to the formation of a diploid (2n) zygote. The zygote, then, divides by mitotic division and develops into an individual.
- Thus, reproduction basically involves cell division. Before a cell can divide, it must unravel its chromosomes, and copy all its DNA (Deoxyribonucleic acid), so that each new daughter cell can get a complete copy of the genetic information.
- Key concept of reproduction is the formation of a DNA copy. By the use of biochemical reactions, cells build up copies of their DNA. DNA copying is accompanied by the formation of an additional cellular apparatus and then the DNA copies separate, each with its own cellular apparatus. Thus, a cell divides to give rise to two daughter cells.
- DNA present in a cell carries information for making proteins which help in expression of body characters. If this information is altered, it will eventually lead to the formation of altered proteins and hence lead to abnormal body characters.
- Alternation of DNA actually depends on how accurately the reactions which are involved in DNA replication (copying of DNA) occurs. No biological reaction is absolutely reliable. Therefore, it can be expected that the process of copying of DNA may have some variations each time it occurs. As a result, the DNA copies generated will be similar, but may not be identical to the original.
- Some of these variations might be so drastic that the new DNA copy cannot work with the cellular apparatus it inherits. Such a newborn cell will simply die. On the other hand, there could still be many other small variations in the DNA copies that would not lead to such a drastic outcome. Thus, the surviving cells are similar, but not identical to the parent cell. This inbuilt tendency for variation during reproduction is the basis of evolution of new species.

Significance of variation:

- Population of several organisms fill well-defined places, in the ecosystem, using their ability to reproduce. The consistency of DNA copying during reproduction is important for the maintenance of body design that allows the organism to use that particular ecosystem. Therefore, reproduction is linked to the stability of populations of species.
- Sometimes, there can be changes in the ecosystem or organisms such as rise or fall in the earth's temperature, changes in water levels or meteorite hits etc. If a population of reproducing organisms were suited to a particular ecosystem and if the ecosystem were drastically altered, the population could be wiped out. However, if some variations have occurred in a few individuals in these populations, there would be some chance for them to survive. For instance, if there were a population of bacteria living in temperate waters, and if the temperature of water increases due to global warming, most of these bacteria would die, but the few variants resistant to heat would survive and grow further. Variations here are thus useful for the survival of species over time.

Types Of reproduction

Living organisms reproduce in two ways- asexual reproduction and sexual reproduction.

Asexual Reproduction:

Asexual reproduction involves the production of an offspring from a single parent without the fusion of gametes. Asexual reproduction mostly occurs in unicellular organisms (like bacteria, protozoans, etc), some plants (like algae, fungi, bryophytes, etc) and certain multicellular animals (like sponges and Hydra). In this method of reproduction, the young one receives all its genes from one parent.

Basic features of asexual reproduction

- Only one organism is involved; different sexes are not involved.
- All the cell divisions during this type of reproduction are either mitotic or amitotic.
- New individuals produced are genetically identical to the parents.
- It is a rapid mode of multiplication.
- No gametes are formed and hence no fertilization takes place.

Types of asexual reproduction

There are many types of asexual reproduction such as fission, fragmentation etc.

Fission:-Fission may be defined as the splitting of an unicellular organism into two or more than two separate daughter cells.

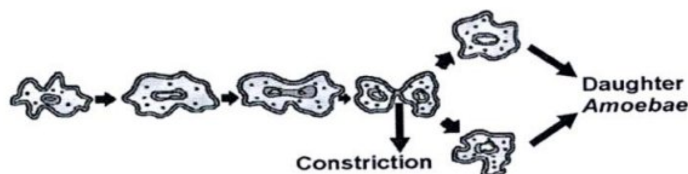
This type of reproduction is common in unicellular organisms, like Amoeba, Paramecium and Euglena. Fission is of two types – binary fission and multiple fission.

Binary fission:-This is the division of parent cell into two small, nearly equal sized identical daughter cells. The two daughter cells then grow into adult organisms.

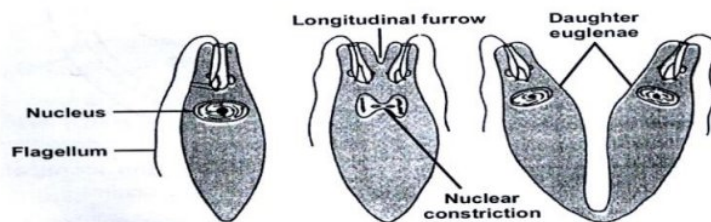
In this type of reproduction, the nucleus first divides into two nuclei, this is followed by the divison of cytoplasm. The cell finally splits into two daughter cells. The two daughter cells grow fully and divide again.

This method of reproduction occurs in favourable conditions of life. The daughter cells formed are morphologically and genetically identical. Binary fission can be seen in bacteria, Amoeba, yeast and Euglena. Binary fission is of following types:

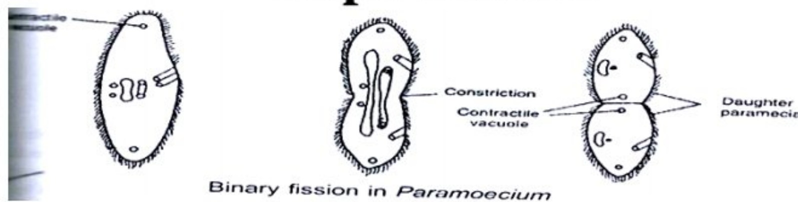
i) **Simple Binary Fission (Irregular Binary Fission)**:- Division can occur through any plane, i.e., the plane of division can pass through and axis, e.g. Amoeba.



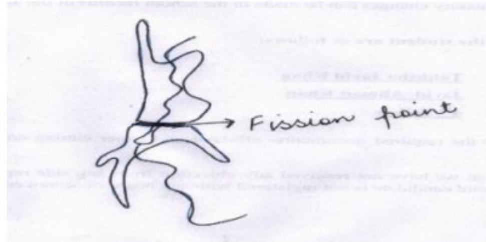
ii) **Longitudinal Binary Fission**: The plane of fission passes along the longitudinal axis of the organism, e.g. Euglena, Vorticella and Leishmania.



iii) **Transverse Binary Fission**:- The plane of binary fission runs along the transverse axis of the individual, e.g., Paramoecium, diatoms, bacteria.



iv) **Oblique Binary Fission**:- The plane of division is oblique. It occurs in dinoflagellates, e.g., Ceratium.



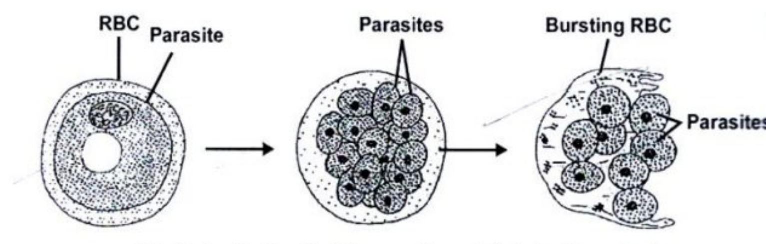
Oblique Binary Fission In Ceratium

Differences between Binary Fission and Multiple Fissions.

Binary Fission	Multiple Fission
1. It gives rise to two daughter individuals.	1. It forms many (more than two) daughter individuals.
2. It occurs during favourable conditions.	2. It can occur under favourable (e.g. Plasmodium) as well as unfavourable conditions (e.g. Amoeba).
3. Nucleus of the parent cell divides only once to form two daughter cells.	3. Nucleus of the parent undergoes repeated divisions to form a number of daughter nuclei.
4. Cytoplasm divides after nuclear division.	4. Cytoplasm does not divide after every nuclear division.
5. No part of the parent body is left unused. Example: Amoeba, Paramecium	5. A part of the body, covering and residual cytoplasm, is left behind. **Example**. Plasmodium, Amoeba (encysted)

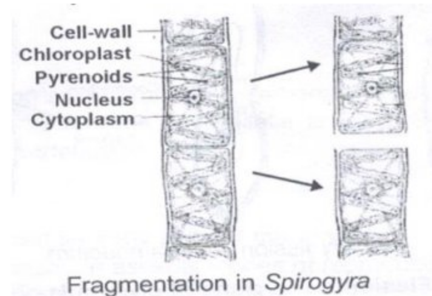
Multiple fission:-It is a type of fission in which many individuals are formed from a single parent. This method of reproduction occurs in unfavourable conditions like drought, climatic conditions. The unicellular organism develops a protective covering called cyst over the cell. The nucleus of the cell divides repeatedly producing many nuclei. Later on, each nucleus is surrounded by small amount of cytoplasm and many daughter cells are produced within the cyst.

When conditions are favourable the cyst breaks and small offsprings are liberated. This type of reproduction is seen in many algae and in some protozoans, such as the malarial parasite (Plasmodium). Amoeba also shows multiple fission under unfavourable conditions.



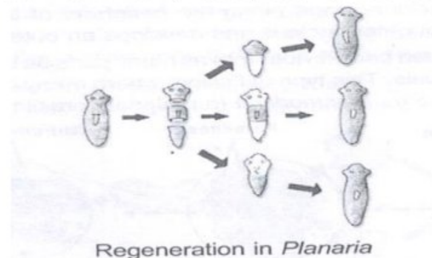
Multiple fission in plasmodium

Fragmentation:- It is a mode of asexual reproduction in which an organism reproduces by breaking of their bodies into small pieces called fragments which later on grow into new individuals.
Fragmentation is a method of reproduction in some multicellular organisms that have simple body organization. These organisms are comprised of a random collection of cells without differentiation of specialized tissues and organs.
This method of reproduction is found in many organisms such as planaria, hydra, spirogyra, etc.

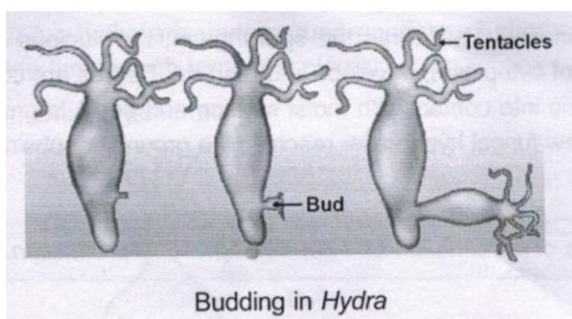


Fragmentation in *Spirogyra*

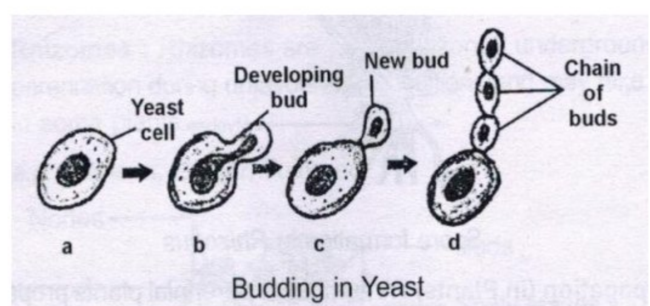
Regeneration:- It is defined as the ability of an organism to regenerate its lost parts of the body which have been removed by injury or autonomy.
Regeneration is common in lower plants e.g. algae, fungi, etc and animals also like hydra, planaria and sponges. E.g. if the body of planaria is cut into small pieces, each piece can regenerate into an entire individual.


Regeneration in *Planaria*

Budding:- Budding may be defined as the production of new individual from an outgrowth of the parent individual. Budding occurs in yeast, some protozoans and certain lower animals e.g Hydra, Scypha, Syllis, Salpa, etc.
In multicellular organisms such as Hydra, a small outgrowth arises from one side of the body. The outgrowth grows, and develops adult like structure and finally gets detached to lead an independent life.

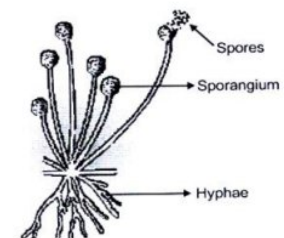


Budding in *Hydra*



Budding in Yeast

Spore formation:- Reproduction by the formation of spores is a common method of asexual reproduction in some bacteria and most of the fungi. During the formation of spores, the fungus develops an enlarged sporangium. The nucleus of developing sporangium divides several times. Each nucleus, within the developing sporangium, gets surrounded by a bit of cytoplasm and develops into a spore. The spores mature inside the sporangium. They are liberated by rupturing of sporangial walls and dispersed to grow on new substratum by



Spore formation in *Rhizopus*

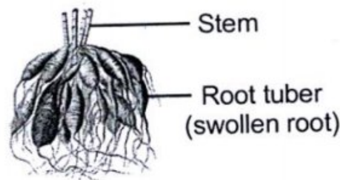
forming new fungal hypha. Each spore then grows into a new individual e.g. Rhizopus, mucor, aspergillus, pencillium, bread mould etc.

Spore:- It is a single or several celled reproductive structure that detaches from the parent and gives rise, directly or indirectly, to a new individual.

Vegetative propagation (Vegetative reproduction)
Vegetative propagation in plants is a method of asexual reproduction in which the parts other than seeds are used as propagules (i.e. the structural unit that is employed in place of seed). It is a method of propagation in those plants which have lost their capacity to produce seeds or they produce non-viable seeds (e.g. banana, seedless grapes, rose, pineapple, etc). Vegetative propagation occurs by natural as well as by artificial methods and is very common in seedless plants. Some most common natural methods of vegetative propagation in plants are:

Natural (Vegetative Propagation)
It is done by following means:

a) **By Roots:**
Roots of some plants develop adventitious buds which grow to form new plants. e.g. Dalbergia (sheesham), Guava, Sweet potato, Dahlia, Asparagus etc.

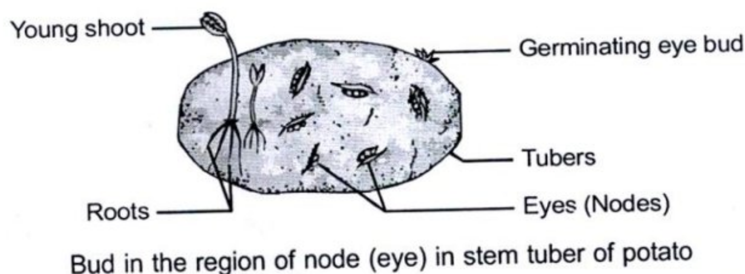


Root tuber of Dahlia

b) **By Stems:**

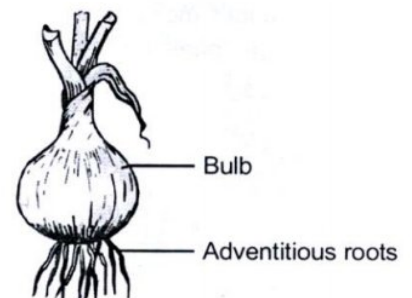
1) **Underground stem:** Different types of underground stem structures bearing a few buds take part in vegetative propagation. Some examples are given below:

i) **Tubers:** Potatoes are vegetatively propagated by tubers. These have buds or eyes over their nodes. The buds produce new plantlets when a stem tuber or a part of it having an eye is placed in the soil.



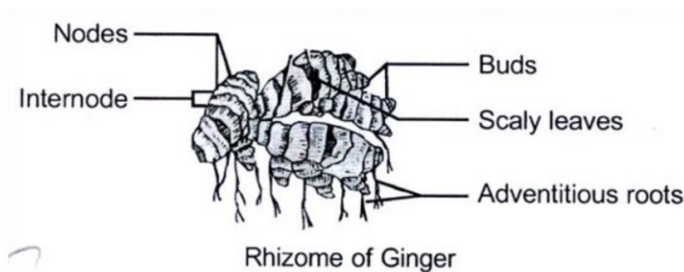
Bud in the region of node (eye) in stem tuber of potato

ii) **Bulbs:** Bulbs are underground condensed shoots which have one or more buds inside them which form new plants e.g. Onion, garlic etc.



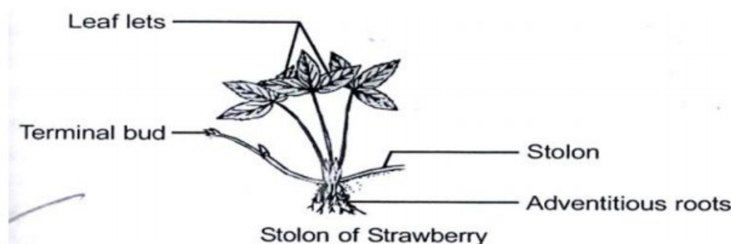
Bulb of Onion

iii) **Rhizomes**: Rhizomes are main horizontal underground stems which store food for perennation during unfavourable conditions and may take part in vegetative propagation in some plants. E.g. Banana, Ginger, Tumeric.



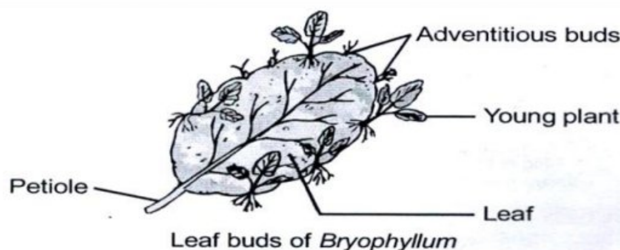
Rhizome of Ginger

iv) **Subaerial or creeping stems:-** The subaerial or creeping stem of some plants also take part in vegetative propagation. For example, stolons in strawberry. Stolons are arched horizontal branches that develop at the base of a crown and help in vegetative propagation.



Stolon of Strawberry

c) **By Leaves:** Leaves of many plants have adventitious buds and help in vegetative propagation e.g. Begonia, Bryophyllium, Saintpaulia etc. The leaf buds fall on the soil and develop into new plants.



Leaf buds of *Bryophyllum*

Artificial methods of vegetative propagation are man-made and developed by plant growers and horticulturists for commercial production of crops. Some common artificial methods are:

i) **Cutting**:- The small piece of any plant organ (stem, root or leaf) used for propagation is called cutting. Stem cuttings are most commonly employed for propagation of many horticultural plants such as grape, tea, citrus fruits, rose, sugarcane, etc. In this method, about 20-30cm long pieces of stem are planted in natural position in the wet soil. It gives off roots from the lower end and shoots buds from the aerial nodes. A cutting develops into a new plant, similar to the parent plant.

ii) **Layering:-** In layering, the roots are artificially induced on the stem branches before they are detached from the parent plant for propagation. Layering is done by two common methods:

a) **Mound layering:-** Can be induced by bending the branch to the ground and covering it with moist soil. The apical portion of this branch is left exposed to air which develops leaves. The part below the soil develops adventitious roots. The layered branch is then separated from the parent plant and it grows into an independent plant. Layering is practiced in plants like jasmine (Jasminum), Magnolia, etc.

b) **Air layering method:-** In this method, a part of the aerial branch is scarped. The scarped part is wrapped with damp mud. A polythene or plastic sheets is used to cover the mud in order to prevent

water loss. Water may be sprinkled over the wrapped mud at intervals to keep it moist. After few weeks roots emerge out from the scarped part of the stem. At this stage the stem with newly developed root system is removed from the parent stem to be planted in soil. Several plants, like jasmine, strawberry, guava, lemon, china rose (Hibiscus), Bougainvillea and several others can be grown through this method.

iii) **Grafting** is a method of obtaining a superior quality plant from two different plants by taking the root system of one plant and the shoot system of another. The plant whose root system is taken is called stock while the plant whose shoot system is taken is called scion. Thus, grafting is a method in which cut stems of two plants, stock and scion, are joined in such a way that they develop into a single plant. The ends of the stock and the scion to be grafted are cut obliquely and placed face to face in such a way that the cambia of the two are in intimate contact. Then both the scion and the stock are bound firmly with tape and covered with soft wax to prevent them from infection and dehydration. After some time new cells develop in the cambia of the stock and scion. They form a close union and the buds sprout. This technique has been used in raising superior quality plants of mango, guava, pear, rubber, etc.

Advantages of vegetative propagation
- The desirable characters (traits) of the plants can be preserved through generations by vegetative reproduction.
- Seedless plants like rose, sugarcane, banana, grapes, jasmine, etc. can be grown through vegetative propagation.
- Through cutting and grafting methods, flowers and fruits can be grown in a shorter time as compared to the plants grown from seeds.
- It is a cheaper, easier and more rapid method of plant propagation.
- The plants, which do not produce viable seeds or produce very few seeds, can be reproduced by this method, for example, banana, potato, grapes, sugarcane, rose, orange, etc.
- Plants raised through vegetative propagation from a single parent are generally identical.

Limitations of vegetative propagation
There are some limitations of vegetative propagation. Some of these are:
- Plants produced by this technique possess less vigour.
- They are more prone to diseases.
- They show no genetic variations.

Tissue culture
It is a modern technique of vegetative propagation. This technique is also called micro propagation. In this technique, a small part of tissue is cut from a plant and is grown on artificial culture medium in a container containing nutrient medium under aseptic conditions. The tissue utilizes nutrients from the medium and forms an unorganized, undifferentiated mass of cells called callus. Small portion of this callus is separated and transferred to another medium containing hormones. These hormones induce differentiation and plantlets are produced. These plantlets are transplanted into the soil, which grow into mature plants. Orchids, asparagus, chrysanthemum and many other plants are now being grown by using tissue culture technique.

Advantages of Micro propagation
i) A large number of plants can be produced in relatively short span of time and space.
ii) Helps in crop improvement by producing disease-free plants.

Significance of Asexual Reproduction are as follows:
i) This type of reproduction enable organisms to reproduce without a mate.
ii) It does not require the time and energy that takes to search a mate.
iii) It results in the reproduction of large number of offspring rapidly.
iv) Like in plants, it enables to spread and colonize an area in short period of time.

v) Animals that are confined to one particular place and unable to look for a mate reproduce asexually.

vi) Stable environments with very little change are favourable for organisms to reproduce asexually.

Sexual Reproduction

It is the process of development of new individuals through the formation and fusion of male and female gametes. It is usually biparental and involves sexual individuals –male and female. The process of fusion of two different types of gametes i.e. male gamete (sperm) and female gamete (egg) is called fertilization. The events of sexual reproduction can be broadly divided into following phases:

i) **Prezygotic / gametic phase:** It involves sperm formation (spermatogenesis) in males and ovum formation (oogenesis) in females. Males and females have different reproductive organs for the production of their gametes.

ii) **Zygote phase:** It involves fusion of gametes (sperm and ovum) which results in the formation of zygote. This process is called fertilization/ syngamy.

iii) **Postzgotic phase:-** It includes events of growth and development t of the embryo and feotus from a single cell called zygote.

Sexual Reproduction in flowering plants:-

Structure of a flower

In flowering plants, all the steps of sexual reproduction occur within specialized reproductive organs called the flowers. Thus a flower may be defined as a specialized condensed reproductive shoot of flowering plants on which are inserted the essential reproductive parts.

A typical flower consists of four whorls of floral appendages attached on the receptacle. The flowers stalk is called pedicel. The tip of the pedicel is enlarged into a receptacle called thalamus. All the other floral parts are attached to the receptacle in circles or whorls. The four whorls of floral appendages are:-

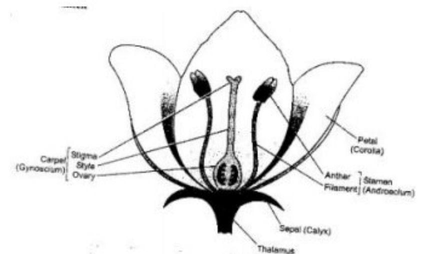
1. Calyx or sepals.
2. Corolla or petals
3. Androecium or stamen.
4. Gynoecium or carpels.

1. **Calyx or sepals:-** It is the outer most whorl of floral leaves. Sepals are green, leaf like structures. Sepals protect the flower when it is at the bud stage. The collective name for sepals is calyx.

2. **Corolla or petals**:- The next circle of appendages is that of petals. They are generally bright in colour as well as fragrant. The colour and smell help in the process of pollination. Petals are collectively called corolla. Calyx and corolla are non essential parts of a flower because they are not directly involved in reproduction.

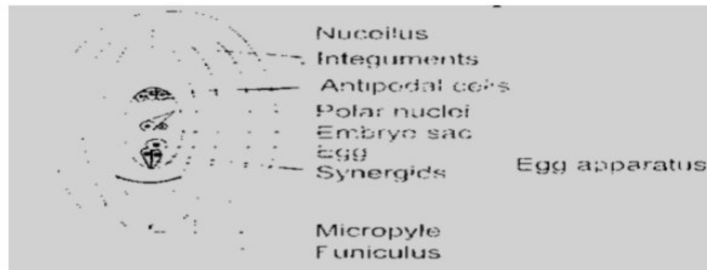
3. **Androecium or stamen:-** The third whorl, inner to corolla, consists of stamens. They are the male reproductive organs of the flower. Each stamen consists of a slender stalk, the filament and a tiny bulb like structure at its tip known as anther. Usually anthers are bilobed and contain four pollen sacs. The pollen grains are made inside the pollen sac. Stamens are collectively called the androecium.

4. **Gynoecium or carpels:-** The inner most whorl at the centre is the female reproductive organ known as carpel. Each carpel has three distinct parts namely stigma, style and ovary. Ovary is the swollen basal part, which extend upwards into a stalk like style, which terminates into a lobed head, called as stigma. The ovary bears one or more ovules. The collective name for carpel is called pistil.



Structure of an Ovule

The ovule develops from a special tissue called the placenta, inside the ovary. The ovule is attached to the ovary wall by a stalk known as funiculus and it is surrounded by one or two protective layers called integuments.
The integuments leave a small opening called as micropyle. Within the ovule an oval shaped structure called the embryo sac is formed as a result of meiotic division.
In the embryo sac are present eight cells, which are arranged in three sets. The set of three cells at the micropylar end form the egg apparatus which comprises the egg cell and two synergids on either side of the egg cell. The next set of three cells, at the other end of the embryo sac is called antipodal cells, remaining two in the centre fuse the form a diploid secondary nucleus or two polar nuclei.



Structure of ovule

Pollination:- The transfer and deposition of pollen grains from the anther on the stigmatic surface of the flower is termed pollination. When the pollen grains from the stamens are transferred to the stigma of the same flower, the process is termed autogamy (self-pollination). This happens in bisexual flowers such as pea, wheat, etc. When the pollen grains are transferred from one flower to another flower of the same plant, the method is termed geitonogamy which is again a type of self-pollination. Cross-pollination occurs between flowers of two different plants of the same species. It is termed allogamy.

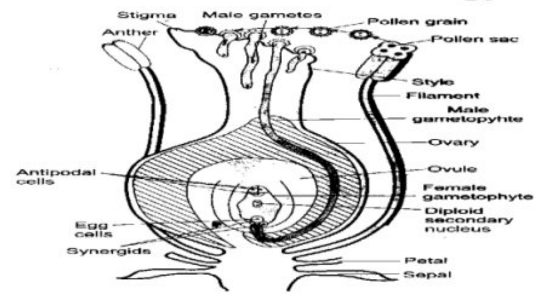
Pollinating Agencies:- The different agents that help in the process of pollination are:-
Wind, water, insects, birds, bats, bees and butterflies, humans etc.

i) When pollination is done by wind, 'it is called as anemophily.
ii) When pollination is done by water, it is called as hydrophily.
iii) When pollination is done by insects, it is called as entomophily.
iv) When pollination is done by bats, it is called as chiropterophily.
v) When pollination is done by birds, it is called as ornithophily.
vi) When pollination is done by bees and butterflies, it is called as psychophily.
vii) When pollination is done by humans, it is called as anthrophily.

Fertilization: Pollination results in the deposition of related pollen grains over the receptive stigma of the carpel. They absorb water and swell up.
Each pollen grain contains two nuclei, one is the generative nucleus and the other, the vegetative nucleus. A pollen tube emerges from the pollen grain and penerates through the style. The pollen tube bears the vegetative nucleus at its tip.
The generative nucleus divides into two male nuclei. The pollen tube eventually enters the embryo sac through the micropyle and discharges the two male nuclei (gametes) into it. The vegetative nucleus then disintegrates.
Inside the embryo sac, one of the male nuclei fuses with the egg cell and forms a diploid zygote. The process is called as syngamy or generative fertilization. The other male nucleus fuses with the two polar nuclei situated at the centre of the embryo sac to form the triploid primary endosperm nucleus. This fusion is termed triple fusion or vegetative fertilization by virtue of the union of three nuclei. Fertilization occurs twice in the embryo sac. One between the egg cell and one of the male nuclei, and the second between the two polar nuclei and the second male nucleus. So it is termed double fertilization. The summary of double fertilization is given below.

i) Egg cell (haploid) + 1st male nucleus = Zygote (diploid)
ii) Two polar nuclei (diploid) + 2nd male nucleus (haploid) = Endosperm (triploid)

The endosperm tissue is used as food by the developing embryo. Following fertilization the petals, stamens, style and stigma fall off. However, the sepals dry up and hold onto the developing ovary. The ovary grows rapidly and forms a fruit and the ovule develops into a seed. The seed contains a potential tiny plant that is the embryo. The embryo has a root-like structure called the radicle and a shoot-like structure, the plumule. There may be one or two fleshy structures known as cotyledons attached to the embryo, in between the plumule and radicle. Cotyledons contain reserve food for the developing embryo.



Sexual Reproduction in Animals

In human beings, reproduction involves both the male and female sexes. The new individual or offspring develops from the zygote by the union of two specialized cells called gametes. One of the gamete is active, smaller in size and without any reserve food. This is the male gamete and is called sperm.

Male Reproductive System

Human male reproductive system consists of the following organs:-

1. Testes
2. Scrotum
3. Vas Deferens
4. Urethra
5. Penis

1. **Testes:-** Human male possesses two testes, which are the primary reproductive organs, lying outside the abdominal cavity. The two testes are the male gonads, which are the sites where male gametes i.e. sperms are made. Testes contain coiled masses of tubes called semineferous tubules. These tubes are responsible for producing sperm cells. Walls of semineferous tubules contain elongated sertoli cells and rounded interstitial or leydig's cells which secretes male sex hormone called testosterone. The testis of male produces sperms from puberty onwards, throughout his life. Approximately 300 million sperms are produced every day.

2. **Scrotum:-** It is pouch of skin that hangs between the legs. It is divided internally into right and left scrotal sacs by a muscular partition. The two testes lie in respective scrotal sacs. Scrotal sacs act as thermoregulator and provides an optimal temperature for the formation of sperms. The sperms develop at a temperature 1-3^{0}C lower than the normal body temperature. The life of the sperms is greatly reduced if the temperature is higher.

3. **Vas Deferens/ epididymis**:- These are long coiled tubes that rest on the backside of each testicle. These transport and store sperms. It is a straight tube, about 40cm long, which carries sperms to the seminal vesicles. Sperms are stored temporarily in the seminal vesicle, where mucus and a watery alkaline fluid containing the sugar fructose, mix with the sperms.

4. **Ejaculatory duct**:- These are a pair of ducts which are formed by the fusion of vasdeferens and seminal vesicles. The ejaculatory duct opens into urethra.

5. **Urethra:-** It is about 20cm long tube that arises from the urinary bladder to carry urine. It runs through the penis and opens to the outside through male genital pore. The contents of the two seminal vesicles, i.e. sperms from vas difference also join the urethra. Thus urethra carries urine from the bladder, as well as sperms from vasa differentia, through the penis.

6. **Penis:-** It is a long and thick muscular organ made up of mostly erectile tissue. The tip of penis consists of a soft and highly sensitive glans penis, which is covered by a loose, retractable fold of skin, called foreskin. At the time of sexual excitement, the erectile tissue gets filled with blood causing the penis to become erect. It is inserted into the vagina of the female where sperms are ejaculated for the purpose of reproduction.

   In human males, there is only one opening for the urine and sperms to pass out of body.

Accessory male glands

Seminal vesicle:- These are two in number. The secretion of seminal vesicle forms the major part of the seminal fluid. The sperms become active in the secretion of seminal vesicle. It secretes mucus and a watery alkaline fluid that contains fructose. Each seminal vesicle releases its contents into ejaculatory duct during ejaculation.

Prostate gland:- This gland surrounds the urethra. The secretion of the gland is thin and milky and is directly discharged into the urethra.

Cowper's gland / Bulbourethral gland:- These are two in number and are attached to urethra, a little below the prostate gland. It secretes mucus and an alkaline fluid into the urethra. The secretion of the Cowper's gland and the prostate gland make an environment in the urethra suitable for sperm survival.

Structure of sperm:-

The structure of mature sperm is as under:-

There are three distinct regions: a head, a middle piece and a tail. The head is flattened and oval in shape. It contains a nucleus and is capped by an enzyme-filled structure called the acrosome. Acrosome facililitates the entry of the sperm nucleus into the egg cell at fertilization. The middle piece of the sperm has several mitochondria for energy production. The tail helps in propulsion through the female genital tract. The entire development of the sperm takes about 72 days. In man, spermatogenesis (the process of sperm formation) is continuous but in other mammals it may be seasonal and restricted to certain breeding periods. Temperatures above 40^0C inhibit spermatogenesis (for this reason the testes are located outside the body).

Female Reproductive System

Female reproductive system is more complex as compared to that of males. The complexity of sexual structures in females is due to the fact that it accepts sperms from male, supports their movement upto egg, fertilization and subsequent post fertilization changes. Female reproductive system consists of the the following organs:

1. Ovaries
2. Fallopian tubes (Oviducts)
3. Uterus
4. Vagina
5. External genitalia

1. **Ovaries:-** Each human female contains two almond shaped ovaries located in the lower part of abdominal cavity near the kidney. Each ovary is connected by a ligament to the uterus. The ovaries are primary sex organs (or female gonads), which perform the dual function-(a) production of female gametes (eggs or ova) and (b) Secretion of female sex hormones (estrogen and progesterone). Each ovary is composed of ovarian follicles, at various stages of development. Each follicle contains a large ovum surrounded by many layers of follicle cells. The production of ova starts at the age of puberty. Usually, one ovum is produced every month during the fertile years of a woman. After menopause, the ovaries become small and lose follicle.

2. **Fallopian tubes (Oviducts):-** A fallopian tube is about 10-12cm long muscular tube which carries egg from the ovary to the uterus and also provides the appropriate environment for its fertilization. The funnel-shaped opening end of each fallopian tube lies near the posterior ends of each ovary. It bears finger like projections called fimbriae which are attached to ovary by ligaments. The other ends of the long convoluted tubes open into the uterus.

3. **Uterus:-** The uterus is a large, inverted pear-shaped, muscular structure that lies behind the bladder and remains attached to body wall by ligaments. The uterus has a thick muscular wall, the myometrium and a nutritive and highly vascular inner lining the endometrum. If fertilization takes place, the embryo gets attached to the wall of uterus and grows there until birth. The narrower lower part of uterus is called cervix which leads into vagina.

4. **Vagina:-** This is a muscular tube about 7-10cm long whose walls contain elastic tissue. It is well adapted to receive the male's penis during copulation. The vagina is also called "birth canal", as it allows passage of the baby at the time of child birth. The inner lining of the vagina contains secretary gland which produces lubricating and nutritive fluid during sexual arousal. Until puberty, the vagina is partially or almost completely closed by a thin membrane, the hymen, which perforates to allow the flow of menstrual blood.

5. **External genitalia:-** Vagina opens externally into vulva. At its anterior end is the clitoris, a small erectile organ similar to the male penis. Two folds of skin, the labia majora and the labia minora, encloses the vulva at the entrance to the vagina.

Menstrual cycle:-

The cycle of events taking place in female reproductive organs, i.e. in ovaries and uterus, under the control of sex hormones, in every 28 days and marked by bleeding or menstrual flow, is called menstrual cycle (Sexual cycle in Human females).

Each menstrual cycle occurs about every 28 days and lasts 4-5 days. Menstruation occurs 12 to 14 days after an ovum is released from the ovary (ovulation), about once in four weeks. The periodicity of the cycle varies with different individuals. After fertilization, menstruation ceases, and is the first indication of pregnancy. The menstrual cycle is divided into four phases, with major events occurring in each phase.

Menstrual cycle in different stages is described below:-

Stage 1. Menstrual or Menstrual flow:- It lasts for 3 to 5 days. During this stage, the uterine lining the endometrium degenerates causing bleeding. The sloughed off endometrium, the blood and the unfertilized ovum then passes out as menstrual flow.

Stage 2. Post menstrual stage or proliferative phase:- After menstrual flow, the endometrium reappear and the uterus regains its normal structure and size. The follicle grows and matures in the ovary. This stage continues for about 5-13 days.

Stage 3. Ovulation:- Ovulation takes place on about the fourteenth day of the cycle, the follicle bursts releasing ovum. The ovum is picked up by the fimbriae of fallopian tube.

Stage 4. Premenstrual or Progestational stage or luteal or secretory stage:- At this stage the corpus luteum develops from the ruptured follicle and persists over the next 12 to 14 days. The ovum moves to the uterus by ciliary & muscular action in the fallopian tube, if the ovum is fertilized, corpus luteum grow & secretes the hormones mainly. Progesteron prevents ovulation, if the ovum is not fertilized corpus luteum degenerates towards the end of the menstrual cycle.

The menstrual cycle ends in pregnancy or restarts after the removal of the endometrial lining in another menstrual flow. The menstrual cycle and menstruation are permanently discontinued at an age of 45-50 years in females. This is called menopause. The ability to reproduce is lost in females after menopause.

Fertilization:

Internal fertilization is an essential part of reproduction in human beings. This is achieved by copulation (or mating). During copulation, the human male inserts his penis into the vagina of the female and releases gametes (sperms) inside the genital tract. This is called ejaculation. At a time, approximately $3cm^3$ of semen (sperm-bearing fluid produced by testes and accessory glands) is discharged during ejaculation, of which about 10% are sperms. They are millions in number. The sperms are deposited at the top of the vagina close to the

cervix of uterus. The sperms are highly active and mobile. They travel from here upward through the uterus to the top of fallopian tube within five minutes. There they spend several hours and undergo many chemical changes. Finally, only one sperm fertilizes the ovum in the fallopian tube. The fusion of sperm nucleus with the egg nucleus to form a diploid zygote is called fertilization. Fertilization occurs only when copulation occurs during ovulation period (i.e. middle of the menstrual cycle). It is marked by the stoppage of menstrual flow. Thus, stoppage of menstruation (the 'period') is the earliest sign of pregnancy.

Post fertilization changes:
Immediately after conception (i.e., fusion of male and female gametes to form a zygote), the embryonic development begins in the fallopian tube. This stage marks the beginning of pregnancy. As the zygote moves from the fallopian tube down towards the uterus, it starts dividing by successive nuclear and cell divisions resulting in the formation of a small multicellular ball of cells by the process, called cleavage. The young multicellular embryo, formed as a result of cleavage, is now called blastocyst. The blastocyst gets embedded into the thickened inner wall of the uterus. The close attachment of the blastocyst to the uterine wall is called implantation. It takes place about seven days after fertilization.
Implantation is followed by a number of development changes in the blastula, as well as, in the wall of uterus. These changes include the formation of different embryonic layes (ectoderm, mesoderm and endoderm) and successive development of youth foetus (embryo). The first organs, formed in developing foetus, are neural tube and spinal cord. These organs begin to develop in the third week. Subsequently, a special umbilical cord develops in the fourth week which establishes an intimate connection between the foetal membrane and the uterine wall, called placenta. In the placenta, the foetal blood comes very close to the maternal blood. Here the exchange of materials between the mother's blood and the blood of foetus take place. The foetus gets nutrients, water, oxygen, minerals, vitamins, etc. from the maternal blood and gives off wastes, carbon dioxide, urea, etc. Thus, the placenta serves as the nutritive, respiratory and excretory organ of the foetus.
The complete development of foetus, from the initial stage of conception till the birth of the young one, is called gestation. It is also termed pregnancy. Gestation is completed in about 280 days or 40 weeks from the first day of the menstruation. Gestation is followed by parturition. Parturition is the act of expelling the full-term young one from the mother's uterus at the end of gestation. The new born child, after 280 days of gestation, weighs about 3.5kg and measures about 240 mm from head to bottom.

Reproductive health and sexually transmitted diseases
The reproductive life of human begins, at puberty and continues throughout life in males and upto menopause in females. Like physical fitness, mental, social fitness, human beings need fitness of reproductive life. This is called reproductive health. It includes such aspects that ensure a responsible, safe and satisfying reproductive life. It is our responsibility and the responsibility of nation to provide necessary information and general awareness regarding reproductive health. Everyone mush known that:-

1) Marriage and child bearing during more mature stages of life are important for reproductive health of society.
2) Secondary school education which is lagging behind in many parts must be enhanced.
3) Complications during pregnancy and child birth and unsafe abortion are the causes of death of women.
All these aspects of reproductive health have been considered by W.H.O and National population policy national policy of India.
The infectious (communicable) diseases which are spread from an infected to a healthy person by sexual contact are called S.T.D's(Sexually transmitted diseases).
The common among them are:-

v) **Gonorrhea:-** is caused by bacterium (Nisseria Gonorrhea). The victim feeling burning sensation and pain during urination. It causes inflammation of mucus membranes of primogenital tract, throat, eyes. The disease is easily curable by antibiotics.

vi) **Syphilis:-** is caused by a bacterium (Troponema Pallidum). The disease is the chronic illness which affects mucus membrane of genitals, rectum and oral regions and causes lesion. It is easily cured by antibiotics.

vii) **AIDS**:- Is caused by virus HIV. It is the fast spreading incurable disease which weakness the body's immune system. The main symptoms are:-

i) Damage to brain.
ii) Unexplained fever
iii) loss of appetite
iv) Loss of weight
v) Night sweats
vi) Shortness of breath
vii) Severe weakness

It is transmitted only by the contact of infected cells containing blood of patient with the blood of healthy person like use of contaminated needles to inject drug or vaccine, use of contaminated razors for shaving transfusion of blood and blood products etc.

Birth control or Contraception.

The methods or devices of birth control which deliberately prevent fertilization are referred to as contraception.

1. Barier methods.
2. Chemical methods
3. Intrauterine contraception device (IUCD)
4. Surgical methods

These methods are as follows:-

2. Barrier method:

b) **Condoms:-** These are thin, strong rubber sheaths used by man to cover the erect penis. It is simple but effective and widely used contraceptive that has no side effect.

c) **Femidon:-** It is not a common contraceptive method. A femidon is a thin rubber or polyurethane tube which fits inside vagina. It is used by female just before starting coital activities.

d) **Diaphragm**:- It is flexible rubber/ plastic cover that it is fitted over the cervix in the female's vagina which checks the entry of sperms into the uterus.

Chemical methods:- These chemicals adhere to the mucous membrane and immobilizes and kill the sperm:

a) Oral pills are also used to check ovulation. These are mainly hormonal preparations and contain estrogen and progesterone. These prevent development of egg and ovulation by inhibiting secretion of FSH. The oral pills act on hypothalamus, pituitary and the ovaries. They are called oral contraceptives (OCS).

b) Vaginal pills are drugs which contains spermicidal preperations. They are used before copulation by women.

Intrauterine contraceptive device (IUCD):- These are contraceptive devices made of copper plastic or stainless steel. A copper – T is inserted into uterus by a practicing doctor or a skilled nurse and left in place. It prevents implantation in the uterus.

Natural method:- These method includes abstinence, rhythm method (avoid copulation around the time of ovulation) and coitus interrupts (with drawal of penis before ejaculation)

Surgical method:- Surgical method are safe in the long run but they may cause infection and other problems if not done properly. These methods include:

a) **Vasectomy: -** This a small surgical operation performed in males. It involves removal of a small portion of the sperm duct (or vas deferens) by surgical operation. The two cut ends are then ligated (tied) with threads. This prevent the sperms from coming out.

b) **Tubectomy:-** This is a surgical operation performed in females. It involves removal of a small portion of the fallopian tubes by surgical operation. The cuts are then ligated with threads. It prevents the egg (ovum) to enter the fallopian tube.

Medical Termination of Pregnancy (MTP): Abortion is done to end the pregnancy. Surgery can also be used for removing unwanted pregnancies. In many cases, it is misused by people who do not want a particular child, as in the case of illegal sex-selective abortion of female fetuses.

Placenta and its functions.
Placenta is a temporary organ formed in the mammals only and is the only organ in animals formed of the tissues derived from two different individuals, the foetus and the mother to permit the exchange of materials between the two.
The placenta has two parts. The part contributed by the foetus is called the foetal placenta; and the part shared by the mother i.e. part of uterine wall is termed the maternal placenta.

Functions of placenta:-
1. **Nutritive organ**:- food material passes from the mother's blood into the foetal blood through the placenta.
2. **Digestive organ:-** The placenta digests (break down) proteins before passing them into the foetal blood.
3. **Respiratory organ:-** Oxygen diffuses from the maternal blood into the foetal blood through the placenta. Carbon dioxide diffuses from the foetal blood into the maternal blood also through the placenta for elimination by the mother's lungs.
4. **Excretory organ:-** Nitrogenous wastes, such as urea pass from the foetal blood into the maternal blood via placenta for elimination by mothers kidney.
5. **Endocrine organ:-** Placenta secretes human chronic gonadotrophin (HCG) oestrogens, progesterone and human placental lactogen.
6. **Storage organ:-** The placenta stores glycogen for the foetus before liver is formed.

- **Puberty, changes at puberty and secondary sexual characters:**

  Puberty:- The age at which the sex hormones and gametes begin to be produced and boys and girls become sexually mature. Generally boys attain puberty at the age of 14-15 years while girls reach puberty at a comparatively lower age of 11-12 years.

  Changes at puberty
  The following changes start taking place in the body of boys and girls

1. **Increase in height:-** There is a sudden increase in the height of both boys and girls during puberty. This occurs due to the increase in the length of arms and legs. The rate of growth in height varies from person to person. Some may grow rapidly at the start of puberty and then slow down whereas others may grow gradually.
   The height of an individual depends on the genes which are inherited from parents. During growth period one should take nutritive food for the proper growth of muscles, bones and other parts of the body.

2. **Change in body shape:-** The change occurring in adolescent boys and girls is different. In girls pubic region widens and limbs become broader. Deposition of fat takes place around the hips, face and shoulders. In boys, shoulders become broader and the body muscles grow more than that of girls.

3. **Change in voice:-** At puberty, the voice box begins to grow. The larynx in boys is larger than that in girls. The voice box can be seen as the Adam's apple in their throat. In girls, it is hardly visible because of their small size.
   In boys, voice becomes deep and harsh whereas girls have high pitched voice.

4. **Increased activity of sweat and sebaceous glands:-** The secretion of sweat glands and sebaceous glands (oil glands) increases during puberty. This causes acne and pimples on the face of boys and girls at this time.

5. **Development of sex organs:-** The reproductive organs in boys and girls become fully functional at puberty.
   In boys, the male sex organs like testes and penis develop completely. The testes start producing sperms.

   In girls, the ovary enlarges and eggs begin to mature. Ovaries start releasing matured eggs. Only one egg is released per month.

6. **Production of hormones:-** At puberty testes and ovaries start producing sex hormones. Testes produce the male sex hormone called testosterone and the ovaries produce the female sex hormone called estrogen. The sex hormones play an important role in the process of reproduction and in the development of secondary sexual characters.

7. **Reaching mental, intellectual and emotional maturity:-** Adolescence to a period of change in a person's way of thinking. They become more independent and self conscious. Intellectual development takes place and they spend considerable time on thinking, planning, analyzing, evaluating, exchanging views and ideas with others. They need the company of friends and get attracted towards opposite sex.
   During Adolescence stage, young people undergo a period of emotional changes. They may feel depressed and have mood swings and low confidence. They may experience various moods such as being happy, sad, angry, excited or irritated. They think they need a greater degree of freedom, independence and privacy. These are the major causes of mental stress and they start feeling insecure.

Secondary Sexual Characters in Humans:
There are two types of sexual characters in humans:
1) Primary sexual characters 2) Secondary sexual characters

1) **Primary sexual characters:-** Are those characters which are present at birth. These include internal and external sex organs which are present in babies at the time of their birth. The primary sexual characters in males are testes, penis etc and the primary sexual characters in females are ovaries, oviducts, uterus, vagina. The primary sexual characters are directly involved in reproduction.

Secondary Sexual Characters:-
Secondary sexual characters are controlled by hormones and distinguish between sexually matured males and females, but are not directly involved in reproduction. In secondary sexual characteristics the body parts develop special features which make it easier to distinguish boy from a girl. E,g, growth of facial hair in boys and development of breasts in girls are the secondary sexual characters which help to distinguish a girl from a boy.
The secondary sexual characters start developing at the time of puberty and continue to develop through the period of adolescence.

The main secondary sexual characters in males are as follows:

- Facial hairs such as beards and mustaches develop.
- Hairs develop under the armpits, on chest and in the pubic region.
- Voice becomes deeper
- Muscles develop and shoulders become broader.
- Increase in weight.
- Adam's Apple develops in front of throat.

The secondary sexual characteristics in boys/ males are produced by the male sex hormone called testosterone.

The main secondary sexual characters in females are as follows:-

- Development and enlargement of breasts.
- Hairs develop under arm pits, and in the pubic region.
- Hips become broader and become more curved and prominent.
- Pubic region widens.
- Initiation of menstrual cycle.
- Deposition of fat on face, shoulders and around hips.
- High pitched voice/ shrill voice.

The secondary sexual characters in girls are produced by a female sex hormone called estrogen.

Textual Questions

Q#1 What is the importance of DNA copying in reproduction?

Ans. It maintains the body design features in different generations of the species. It also produces variations due to mistakes during copying. Such variations are useful for the survival of species over time.

Q#2 Why is variation beneficial to the species but not necessary for the individual?

Ans. A species comprises a large number of individuals. Each individual may have specific type of variations of different nature. Individually these variations may not be of much benefit to a particular organism but when specie faces a drastically altered condition, some of its members may survive because of possessing such variations which are capable to face the new situation. In this way, variations save the species from becoming extinct and promotes its survival for a long time.

Q#3 Why is DNA copying an essential part of the process of reproduction?

Ans. The process of reproduction results in the production of offsprings which are exactly similar to parents. The exact blue print of body design is inherited in the offsprings due to DNA copying in parent cell during reproduction. Thus, DNA copying is an essential part of the process of reproduction.

Q#4 How does binary fission differ multiple fission?

Ans.

Binary fission	Multiple fission
1. It occurs during favourable conditions.	1. It occurs when an organism faces unfavourable environmental conditions.
2. A single organism splits to form two identical organisms.	2. During this process many new organisms are formed from a single one.
3. Nucleus divides only once during this form of reproduction.	3. Nucleus divides repeatedly to form large number of nuclei.
4. Protective covering is not formed around organism.	4. Protective covering or cyst is formed around the organism during multiple fission.

Q#5 How will an organism be benefit if it reproduces through spores?

Ans. (a) It is a simpler and faster mode of reproduction.

b) Spores being small and light get easily dispersed through wind, water and animals. Thus, dispersal of organism becomes easier.

c) Spores bear thick resistant covering to enable them to survive even in unfavourable conditions.

Q#6 Can you think of reasons why more complex organisms cannot give rise to new individuals through regeneration?

Ans. Complex organisms have specialized cells that are organized as tissues and tissues are organized into organs which then have to be placed at defined positions in the body. In such a carefully organized situation, regeneration would be impractical.

Q#7 Why is vegetative propagation practiced for growing certain types of plants?

Ans.
a) To preserve characters of the plants through successive generations.
b) Seedless plants can be grown through vegetative reproduction.
c) Through cutting and grafting methods flowers and fruits can be grown in a shorter time.
d) It is a cheaper, easier and more rapid method of plant propagation.

Q#8 How is the process of pollination differ from fertilization?

Ans. Pollination is the process of transfer of pollen grains from the anther of a flower to the stigma of the same flower or another, whereas fertilization is a post pollination phase during which fusion of male and female gametes occurs to form zygote.

Q#9 How are the modes of reproduction different in unicellular and multicellular organisms?

Ans. In unicellular organism's asexual mode of reproduction like fission, fragmentation and sporulation are the main source of producing new organisms, however some forms exhibit primitive type of sexual reproduction like conjugation in bacteria.

In multicellular organisms, the primary source of reproduction is through sexual means, although in relatively simpler multicellular forms reproduction occurs by budding, regeneration, spore formation and vegetative propagation.

Q#10 What is the role of the seminal vesicles and the prostate gland?

Ans. Seminal vesicle is a male accessory reproductive gland where sperms are stored temporarily. Here, the mucus and a watery alkaline fluid containing the sugar fructose mix with the sperms. Prostate gland secretes alkaline fluid comprising upto a third of semen volume. It affects the vaginal pH so that sperms move smoothly inside the vagina.

Q#11 What are the functions performed by the testes in human beings?

Ans. Testes are the primary sexual organs of males, which perform the following functions.

- Sperms are formed inside the seminiferous tubules of testes.
- Leydig cells (interstitial cells) of testes produce male sex hormone- testosterone. Testosterone controls the normal growth of genital organs and helps in the development of secondary sexual characters of males.

Q#12 Why does menstruation occur?

Ans. The endometrium of uterus of a female becomes ready to receive foetus at every twenty eight day's interval. If fertilization does not occur and embryo is not formed, endometrium breaks down and bleeding occurs. This process is called menstruation. So, menstruation occurs as a consequence of non-fertilization of egg.

Q#13 What are the advantages of sexual reproduction over asexual reproduction?

Ans. During the process of sexual reproduction gametes are formed which involve DNA copying mechanism, crossing over and fusion of gametes from biparental sources. Error in DNA copying mechanism and crossing over produce different forms of variations in different individuals. Then the

gametes of two individuals with different types of variations combine, they create a new combination of variants. Such variations not only enhance the survival chances for a species but also play an important role in evolution.

During asexual reproduction variations are not produced or even if they appear they are very slow, mainly through mutation, thus are of no use in evolution and survival of species.

Q#14 What are the different methods of contraception?

Ans. The different methods of contraception are:-

1. Barrier methods.
2. Chemical methods
3. Intrauterine contraception device (IUCD)
4. Surgical methods
5. Natural method

Q#15 How does reproduction help in providing stability to populations of species?

Ans. Reproduction is the only means to ensure the continuity of a species. By reproduction, organisms produce a large number of new individuals out of which several get perished and only some survive. These surviving organisms replace the naturally dying organisms of the population. Hence, the population as a whole is not affected and remains stable.

Q#16 Multiple Choice Questions.

a) Asexual reproduction takes place through budding in ;

i) Amoeba ii) Yeast iii) Plasmodium iv) Leishmania

Ans. Yeast

b) Which of the following is not a part of the female reproductive system in human beings?

i) Ovary ii) Uterus iii) Vas deferens iv) Fallopian tube

Ans. Vas deferens

c) The anther contains;

i) Sepals ii) Ovules iii) Carpel iv) Pollen grains

Ans. Pollen grains

Terminology

Heredity: - It is defined as the transmission of characters (resemblances as well as variations) from parents to offsprings i.e., from one generation to the next generation

Variation:- It is derived from Latin word variare which means to change and can be defined as the differences in the traits shown by the individuals of a species, and also by the offsprings of the same parents.

Genetics: It is derived from Greek word "genesis" which means to grow, to become or descent. It is that branch of biology that deals with the study of heredity and variations. The term genetics was coined by "William Bateson in 1906".

Character: It is a distinct, well defined morphological or physiological feature of an individual, e.g., height, eye colour etc.

Trait: It is a character that a living being is able to pass into its young ones through reproduction.

Chromosomes: These are the thread like structures present in the nucleus of a cell. Each chromosome is made up of DNA tightly coiled many times around proteins called histones that support its structure. Each chromosome has a constriction point called the centromere or primary constriction which divides the chromosome into two sections or arms. The short arm of the chromosome is labeled the "p" arm and the long arm of the chromosome is labeled the "q" arm.

Gene or Mendalian factor:- Chemically, it is a segment of DNA. It is the unit of inheritance which is carried from the parent by a gamete in a chromosome and controls the expression of a character in the organism.

Alleles or allelomorphs:- One of a no. of variable or alternative forms of a gene that occupy the same locus on a particular chromosome and control the same character.

Homozygous organisms or genetically pure organisms:- The organisms in which both the alleles of a gene of a character are identical, are called homozygous or genetically pure organisms. It gives rise to offsprings having the same traits on self breeding e.g. pea plants with TT or tt alleles are homozygous for height.

Heterozygous organisms: The organisms in which both the alleles of a gene of a character are dissimilar, are called heterozygous organisms or hybrids e.g. pea plants with allele Tt is heterozygous for height.

Genotype:- It is the genetic constitution of an organism with regard to one or more characters irrespective of whether the genes are expressed or not, e.g. genotype of a hybrid tall is Tt, pure tall is TT and dwarf is tt with regard to the character of height.

Phenotype: It refers to the expressed or observable, structural and functional traits produced by the interaction of genes and environment e.g. height of a plant, colour of a flower etc.

True breeding or pure line generation:- These are the homozygous individuals which produce offsprings of only one type e.g. Tall pea plants will produce only tall pea plants generation after generation on being self pollinated or cross pollinated.

Monohybrid cross:- A breeding experiment dealing with only one character at a time, is called monohybrid cross e.g. height of a plant etc.

Dihybrid cross:- A breeding experiment dealing with two characters at the same time, is called dihybrid cross e.g. height of a plant and shape of a seed.

Polyhybrid cross:- A breeding experiment dealing with many characters at the same time, is called polyhybrid cross e.g. height of a plant , shape of seed, colour of flower etc.

Reciprocal cross: It involves two crosses concerning the same characteristics but with reversed sexes e.g. if in first cross, A is a female and B is a male then in second cross, A will be male and B will be female.

Test cross: The cross of progeny individual with homozygous recessive organisms is called as test cross e.g.

Tt	×	tt
Progeny		homozygous recessive organism

Back cross:- The cross of progeny individual with one of the parents e.g. Tt × TT or Tt × tt

F_1 Generation or First Filial Generation or Son and Daughter Generation:- It is the generation of hybrids produced from a cross between genetically different individuals(parents).

F_2 Generation or second filial generation:- It is the generation of individuals which develops as a result of inter breeding amongst individuals of F_1 generation.

Dominant gene: The gene which expresses itself in heterozygous organisms is called dominant gene.

Recessive gene:- The genes which fail to express itself in presence of dominant allele, is called recessive gene.

Contrasting characters:- The characters which appear in two opposite conditions are called contrasting characters.

Emasculation:- Removal of anthers (male part) of the flower before the maturity of gynoecium (female part) is called emasculation.

Genetic drift:- The elimination of the genes of certain traits from the small population when a section of population dies of natural calamity or migrates to another region.

Accumulation of variations during reproduction

Variations do appear during reproduction whether organisms multiply asexually or sexually. Heredity involves inheritance of basic body design (similarities) as well as subtle changes (variations) in it from one generation to the next generation, i.e., from parents to the offspring. When individuals of this new generation reproduce, the offsprings of second generation will have the basic body design, the differences that they inherit from first generation as well as newly developed differences.

Asexual reproduction involves single parent. When a single individual reproduces asexually, the resultant two individuals again after sometime reproduce to form four individuals. In this way, large numbers of individuals are formed after many generations. All these individuals would be similar. However, there would be only very minor differences between them. These very minor differences arise due to small inaccuracies in DNA copying. Asexual reproduction generates little diversity.

Sexual reproduction, on the other hand, generates even greater diversity. This is so because sexual reproduction involves two parents and every offspring receives some characters of father and some characters of mother. Since, different offsprings receive different combination of characters of their parents, they show distinct differences among themselves as well as from their parents. The variations accumulate and pass on to more and more individuals with each generation.

During sexual, reproduction the variations are caused by

i) Chance separation of chromosomes during gamete formation.
ii) Crossing over during meiosis.
iii) Chance coming together of chromosomes during fertilization.
iv) Mutations.

Rules For The Inheritance Of Traits (Mendalian Genetics):-

A. Contribution Of Gregor Johann Mendel was born in a peasant family of Moravia. Due to poverty, he became a monk in 1843 and later, in 1847, was made an abbot of Augustinian monastery of St. Thomas at Brunn, Austria. From here he went in 1851 to university of Vienna where he studied natural history and mathematics for two years. He also became interested in the

process of hybridization. He returned to the monastery in 1853 and also worked as a teacher in a school. From 1856 to 1865, he conducted breeding experiment on garden pea plant (Pisum sativum) in the garden of his monastery. He published his findings in 1866 in a journal "annual proceedings of the natural history society of Brunn". His findings remained unnoticed because of various reasons:-

1. He published his work in an abscured journal.
2. Failure of scientists to notice his work because scientific world was busy with the controversy arisen by the Darwin's theory of origin of species.
3. His ideas were a head of his time as the ignorance was prevalent in that period about the cytological basis of heredity.

Mendel died in 1884. His work was then rediscovered by three biologists namely, Hugo De Vries of Netherland, Karl Correns of Germany and Erich Von Tshermak of Austria independently in 1900. The forgotten work of Mendel was republished in 1901. His findings formed the basis of genetics and thus he is credited as the father of genetics.

B. Mendel's Experimental Plant:- Mendel selected garden pea plant (Pisum sativum) for series of hybridization experiments because it had following special features:-

i) Garden pea plant had a short life cycle therefore it was possible to study several generations within a short period.
ii) It had several, well defined, distinct, easily detectable contrasting traits.
iii) Flowers were bisexual, male and female reproductive organs mature at the same time and complete enclosure of reproductive parts by petals ensure self pollination.
iv) Artificial cross pollination (hybridization, i.e. removal of stamens with pollen grains of desired plants) could be easily achieved as reproductive organs were large enough to be seen with naked eyes.
v) All the contrasting traits existed in every generation because plants have bisexual flowers and normally resort to self pollination.
vi) Pea plants could be raised, maintained and handled conveniently.
vii) Pea plants produced large number of seeds in one generation. This helped in drawing authentic conclusions.

(C).Mendelian Traits:

Character	Dominant Trait	Recessive Trait
Seed Shape	Round	Wrinkled
Seed Colour	Yellow	Green
Flower Colour	Violet	White
Flower position	Axial	Terminal
Pod Shape	Inflated	Constricted
Pod Colour	Green	Yellow
Stem height	Tall	Dwarf

(D)Mendel's Experimental Technique:- Mendel conducted breeding experiments in three steps:

a) Selection of pure parent plants (i.e., plants producing similar traits in every generation).
b) Productions of first generation of plants by cross breeding (hybridization).
c) Raising of second and subsequent generations by self-fertilization of hybrids.

Mendel performed separate crosses involving traits of one, two and three contrasting characters. These crosses were respectively called monohybrid, dihybrid and trihybrid crosses.

- **Monohybrid Cross: -** Crosses which were made to study the inheritance of one pair of contrasting characters by Mendel are known as monohybrid crosses.

In one such cross, Mendel selected two sets of pea plants with contrasting characters for height. One set of pea plant was about 6// (six feet) in height and the other set was of short plants with an average height of 1// (one foot) Mendel called these plants homozygous tall and homozygous dwarf. These were called as pure strain.

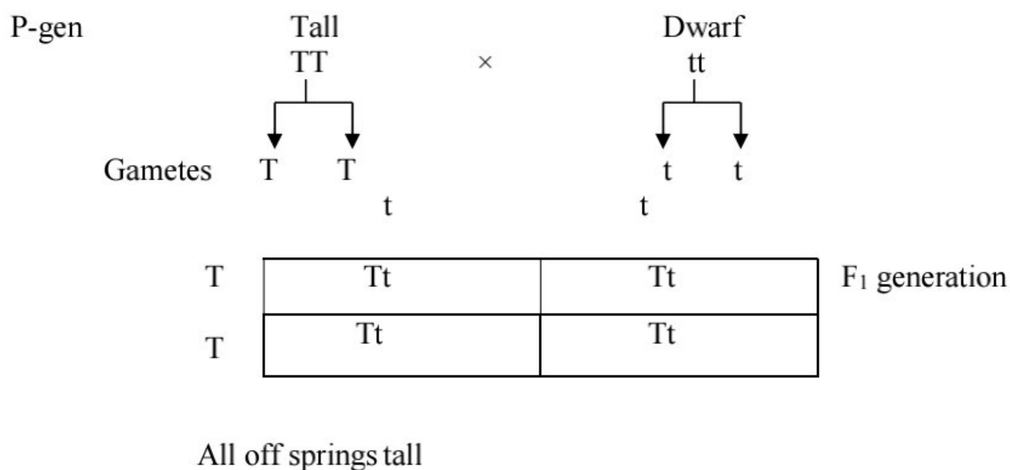
Mendel cross-pollinated homozygous tall plants with homozygous dwarf plants. These plants represented the parent generation (p- generation).

The pollen grains were collected from a flower of tall plant and dusted over the pistils of emasculated flower of dwarf plant. Care was taken that the plants of P generation do not get self pollinated. After cross pollination, the flowers were covered with bags.

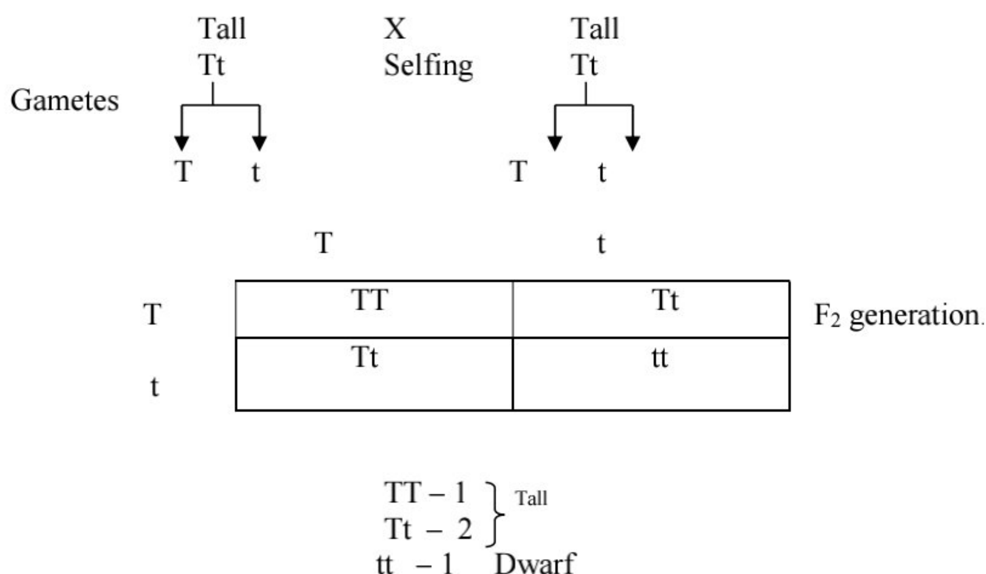
The plants grown from the seeds of parental plants were hybrid plants; these belonged to the F_1 generation or first filial generation. All plants of F_1 generation were tall.

The plants of F_1 generation were self pollinated and seeds were collected. The plants raised from these seeds belonged to second filial generation or F_2 generation.

Mendel observed that among the plants of F_2 generation, 75% were tall and 25% were dwarf, i.e. tall and dwarf plants were produced in the ratio 3: 1.



All off springs tall



TT – 1 } Tall
Tt – 2 }
tt – 1 Dwarf

Phenotypic ratio : Tall: Dwarf
3 : 1

Genotypic ratio : TT : Tt : tt
TT : Tt : tt
1 : 2 : 1

B .Dihybrid Cross:-

When in a cross, two pairs of contrasting characters are considered at a time, then such cross is known as dihybrid cross. Example, cross between two pea plants with round yellow and green wrinkled seeds.

Mendel performed many crosses and in one cross between round- yellow seeds and wrinkled green seeds, he found that only round-yellow seeds were produced in the first generation, the seeds (round – yellow) produced as a result of cross pollination of p-generation plants belongedtoF_1generation. When the F1 generation pea plants were self pollinated by Mendel, then four types of combinations of shape and colour were observed in second generation or F2 generation. These are

i)	Round yellow	9	Parental combination
ii)	Round green	3	New combination
iii)	Wrinkled yellow	3	New combination
iv)	Wrinkled green	1	Parental combination

thus the offsprings of F_2 generation were produced in the ratio of 9 : 3 : 3 : 1. This ratio is called dihybrid ratio.

C. Parental generation — Round yellow — Wrinkled green

Factors — R R Y Y — r r y y

Gametes — RY RY — ry ry

Fusion of gametes — RrYy RrYy R rY y RrYy F1 generation

	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round Yellow	RrYY Round yellow	RrYy Round Yellow
Ry	RRYy Round yellow	RRyy Round Green	RrYy Round yellow	Rryy Round Green
rY	RrYY Round yellow	RrYy Round Yellow	rrYY Wrinkled yellow	rryy Wrinkled Yellow

ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled Green

Thus in F_2 generation

Phenotypic ratio: Round Yellow = 9 ; Round Green = 3
Wrinkled Yellow = 3 ; Wrinkled Green = 1

Genotypic ratio

RRYY : RrYY : RRYy : rrYY : RrYy : rrYy : RRyy : Rryy: rryy
1 : 2 : 2 : 1 : 4 : 2 : 1 : 2 : 1

Mendel's conclusions:- Based on the findings of monohybrid and dihybrid crosses, Mendel concluded that:-

i) In a monohybrid cross, only one of the two contrasting characters (traits) appeared in F_1 generation. However, in F_2 generation, both the parental traits appeared in certain proportion.

ii) In a dihybrid cross, when two contrasting pairs of traits were considered simultaneously, only one parental combination appeared in F_1 generation. However, in F_2 generation, raised by self pollination, four combinations of traits appeared. These included two parental type traits and two new combinations.

Mendel's Principles Of Inheritance or Mendel's Interpretations or laws of inheritance:- The above observations led Mendel to formulate the following postulates or principles or laws of inheritance.

i) **Principle of Dominance (Postulate 1) :-** In a hybrid or heterozygous individual, two dissimilar unit factors are present for one character. Out of two factors (genes) only one is able to express itself and it prevents expression of the other. The one which expresses itself is called dominant gene or factor and the one which remains unexpressed is called recessive factor or gene. For example, in hybrid tall (Tt) only unit factor (gene) of tallness expresses itself, hence it is called dominant. The unit factor (gene) for dwarfness fails to express itself, hence it is called recessive.

ii) **Principle Of Segregation (Postulate 2):-** The two unit factors of a character which remain together in an individual do not get mixed up, or get contaminated and keep their distinct identity. They separate or segregate during gamete formation so that each gamete receives only one factor (gene) for each character and is always pure. This postulate is also called "Principle of purity of gametes".

For example, in a hybrid tall pea plant, unit factors of tallness (T) and dwarfness (t) separate out or segregate out during gamete formation. The two unit factors occur with equal frequency in male and female gametes.

iii) **Principle Of Independent Assortment (Postulate 3):-**This principle states that the unit factor of each character is assorted or distributed into the gametes independently of the unit factors (genes) of any other character and gets randomly rearranged in the offspring. For example, in Mendel's dihybrid cross, the offspring of F_1 generation on self breeding produced four types of offsprings. Two types were similar to parents while the remaining two types had combination of traits. This became possible because the unit factors of the two characters assorted independent to each other.

Importance of Mendelism

Following are points which illustrate the importance of Mendelism:

Improvement of plants: Hybridization is used for obtaining improved varieties of plants. This process results in combinations of desirable characters of two or more species or varieties. In other words, desirable characters of one species are transferred to the other.

Improvement of animals: - Mendelism has enabled the plant breeders to improve the races of domestic animals. Hybridization through artificial insemination has proved highly successful in improving the quality of milk, eggs and other animal products.

Improvement of human race: - Laws of heredity postulated by Mendel are equally applicable to mankind.

Disputed parentage:- Study of inheritance of the blood group can solve the disputed parentage of a child.

Genetic counseling:- With the knowledge of Mendelism, genetic counselor can predict the possibility of hereditary defect in a future unconceived child and even detect genetic disorders in early foetus.

Reason For Mendel's success:-

Following are the reasons for Mendel's success:-

1) His choice of pea plant for his breeding experiments was excellent. He further selected only pure breeding variety for his experiments.
2) He kept a complete record of every cross.
3) He also used statistical methods and laws of probability for finalizing his results.

How do traits get expressed

Inheritance of traits is controlled by genes. Genes are located on the chromosomes. Each gene is composed of DNA. A section of DNA carries information for a particular type of protein to be synthesized. The protein may be an enzyme which controls appearance of a particular character.

Let us take the example of inheritance of height in plants. The height of a plant depends upon the amount of growth hormone. Gene for tallness carries the information for synthesis of efficient enzyme which in turn produces more amount of hormone which leads to greater height of a plant. On the other hand, if a plant has both alleles for dwarfness then less efficient enzymes will be produced which in turn will synthesize less amount of hormone and the plant will remain dwarf.

Sex determination:- The mechanism by which the sex of an individual is determined as it begins life, is called sex determination.

In diploid (2N) organisms with separate sexes, a specific pair of chromosomes determines the sex of the individual. They are called sex chromosomes. All the other chromosomes are called autosomes.

In human beings, 23 pairs of chromosomes are present in each cell. Out of 23 pairs, 23 pairs of chromosomes carry genes which control somatic traits. These are called autosomes. The 23^{rd} pair of chromosomes determines the sex, hence this pair is called sex chromosome or allosome.
The human females have two X- chromosomes (i.e. XX) as sex chromosome. Both the members of sex chromosomes are similar or homomorphic. However, human males have XY sex chromosome, where X- chromosome is morphologically distinct from Y-chromosome. Thus, they are dissimilar or heteromorphic.
The sex of the child is determined at the time of fertilization when male and female gametes fuse to form zygote.
If the sperm (male gamete) carrying X chromosome fertilizes an egg or ovum (female gamete) carrying X chromosome, then the offspring will be a girl (female) and if a sperm (male gamete) carrying Y chromosome fertilizes and egg or ovum (female gamete) which has X chromosome, then the offspring will be a boy (male).
Thus, the sex of the child is determined by the type of sperm that fuses with the ovum at the time of fertilization. Therefore, there is 50% chance of a male child being born and a 50% chance of a female child being born.
This mechanism of sex determination in human beings and also in drosophila is called XX – XY mechanism.
In grasshoppers and some other insects, the male has only one sex chromosome (XO) whereas the female has two homomorphic sex chromosome (XX). This type of sex determination mechanism is called XX- XO mechanism.

Role of Environmental factors in sex determination:
Sex determination is sometimes regulated by environmental factors also. In some reptiles, the temperature at which the fertilized egg is incubated before hatching is important environmental factor for determining the sex of the offspring. Two examples are cited below:

i) First example is of a turtle. In this species, high incubation temperature above 33^0C results in development of female progeny while a temperature below 28^0C produces only males.

ii) Second example is of a lizard. In this species, high incubation temperature results in male progeny while at temperature below 28^0C produces only females.
In other animals, e.g. snails, individuals can change sex, indicating that sex is not genetically determined in this case.

Origin of life:- Life is the property that distinguishes living beings from the non-living object.
Life can also be defined as the inherent capacity of living organisms to utilize the outside materials (light, water, gases or food) for energy, growth and reproduction through chemical reactions (metabolism) in a controlled manner.

Theories on the origin of life:- A no. of theories have been given to explain the origin of life.

1. **Theory of special creation**: This theory stated that life was created by the wishes of a divine being or some supernatural power, the creater or God out of nothing at a particular time in the past. According to Christian belief, God created the universe, plants, animals and human beings in six natural days. “Adam” and “Eve” were the first man and woman created by God. According to Hindu mythology, Lord Brahma created the world with his wish. Manu and Shardha were the first man and woman respectively.
   This theory is purely a religious concept and not based on any scientific fact, thus it was rejected.
2. **Theory of spontaneous generation**:- It stated that life originated spontaneously from non-living materials- abiogenesis for example, fly larvae were believed to develop from rotten meat; frogs, snakes and crocodiles could form from the moist soil (mud) of the river.
   However, this idea was laid to rest by Louis Pateur (1862) who experimentally proved that microorganisms such as protists and bacteria, arise from the pre-existing micro-organisms of their kind. Since then, it is being widely accepted that life originates from pre-existing life-biogenesis.

3. **Cosmozoic or interplanetary theory**:- According to this theory, life could have originated once or several times in various parts of the galaxy in universe and it reached the barren earth from some other heavenly body in the form of resistant spores or seeds. The latter grew and then evolved into various existing forms. This theory is also called theory of panspermia.
   Because of hazards like low temperature, very high influx of cosmic and UV radiations, lack of atmosphere, extreme dryness etc that exist in the interplanetary space and are not conducive to life, this theory of origin of life was rejected.
4. **Theory of Biogenesis:-** This theory states that life originated from pre-existing life. When organic substances are formed from organic substances, it is called as biogenesis.
5. **Abiogenic or Naturalistic theory or chemical origin of life:-** It is now well accepted that life originated from inanimate matter by a series of chemical reactions on the primitive earth. This concept was put forward by Alexander I. Oparin (1923) and J.B.S. Haldane (1929) independently. It was summarized by Oparin in his book "Origin of Life" as " Abiogenesis first, but biogenesis ever since". This theory is now known as primary abiogenesis.
   J.B.S. Haldane , a British scientist suggested in 1929 that life must have arisen on the primitive earth from a collection of chemicals through a progressive series of chemical reactions in which atoms combined into inorganic molecules; inorganic molecules into simple organic compounds; simple organic compounds into complex organic compounds (polymers) and polymers into aggregates which finally got organized into the living matter. This primary abiogenisis is thought to have occurred about 3.6. million years ago.
   Life originated in four stages:
   1. Formation of early molecules.
   2. Formation of simple organic molecules.
   3. Spontaneous formation of complex organic molecules.
   4. Spontaneous formation of molecular aggregates, coacervates, ebionts and the first living cell as well.

   1. **Formation of early molecule**: The primitive earth was a hot gaseous mass. Then the temperature slightly decreased due to which the heavy metals like Iron and Nickel sank to the bottom of the earth and lighter metals like Al and Silica formed the atmosphere. The temperature further decreased below 100^0C and these metals interacted with each other resulting in the formation of gases namely H_2, N_2, NH_3 and CH_4 and water vapour. Depressions were created on the earth which were filled by water and resulted in the formation of water bodies.
   2. **Formation of simple organic molecules:-** The primitive molecules later interacted with one another to form simple organic molecules, namely sugars, fatty acids, glycerol and amino acids. The energy for such interactions was provided by lightening, UV rays and solar energy.
   3. **Spontaneous formation of complex organic molecules:-**The simple organic molecules interacted with one another to form complex organic polymers such as proteins, polysaccharides, lipids and nucleic acids.
   4. **Spontaneous formation of molecular aggregates, coacervates, ebionts and the first living cell:-** The polymers, due to intermolecular interactions formed large colloidal aggregates called coacervates (microspheres). Coacervates contain enzymes, nitrogenous base, phosphate and sugar. Phosphate and nitrogenous base combined together and resulted in the formation of nucleic acids. Nucleic acids formed cytoplasm which gave rise to the first living cell called ebiont or protocell.
      Experimental proof of chemical origin of life: Major support to the above theory was provided by Miller and Urey's experiment in 1953. They designed a glass apparatus and simulated the conditions that thought to have existed on primitive earth. They circulated a mixture of methane (CH_4) , ammonium (NH_3) and hydrogen (H_2) in the ratio of 2:2: 1 and water vapour (H_2O) in this apparatus. These gases were believed to prevail in ancient atmosphere.
      They provided energy for interaction of gases in the form of electric sparks in the gas flask. The mixture was maintained at a temperature just below 100^0C. They kept the experiment working

continuously for 18 days. They then analysed the chemical composition of the products of the chemical reaction in the mixture. They found many simple organic compounds such as amino acids, simple sugars, purines and pyramides.

Evolution:- The word evolution has been derived from Latin words i.e. "e" means from and "volvere" means to roll or to fold.

So evolution means unrolling or unfolding of nature that brings about an orderly change from one form or condition to another resulting descendants becoming different from ancestors. Charles Darwin has defined evolution as descent with modification.

The branch of biology which deals with the study of evolution is called as evolutionary biology and the evolution of living organisms is called as organic evolution which can be defined as a sequence of gradual changes which occur over millions of years and leads to the emergence of complex form of life i.e. from simpler form to complex form, is called organic evolution.

Theories Of Evolution:- Once the concept of evolution was established, several theories were put forwards to explain the process of evolution. The important ones are :

1. Lamarckism or the theory of inheritance of acquired characters:
2. Darwinism or the theory of natural selection.

Lamarcks Theory:-

This theory was given by Jean Baptist Lamarck in his book named "philosophic Zooligique". The main points of this theory are:

1. Environment keeps changing and the change in environment creats new needs.
2. In order to meet these needs for better and successful living, living beings acquire new habits.
3. New traits may involve use and disuse of certain structures in the body.
4. Useful organs modify and enlarge and the organs put to disuse get reduced and gradually disappear.
5. The changes or the variations acquired by the organisms are inherited to their offsprings. This is called as inheritance of acquired characters.
6. The acquired characters caused due to use and disuse of certain organs over a considerably long period of time leads to the evolution of new species.

Criticism of this theory:- The criticism to this theory was given by August Weismann. He said that if we cut the tail of a mouse continuously for 21 generations, a tailless mouse can't be born. This is because the acquired characters are not inherited to the offsprings. Thus, this theory was rejected.

Darwin's Theory:- Charles Robert Darwin explained his work in his book "origin of species". Darwin's theory is also known as theory of natural selection or Darwinsm. The main features of this theory are:

i) **Overproduction**: All organisms possess enormous fertility potential for eg a housefly lays 120 eggs 6 times in one season. If all of them survive in six generations there no. will increase so much that they will require 80,000m^3 space. A single Salmon fish produces 2 crore 50 lakh eggs in a season. If all of them were to survive and reproduce, a single species will fill whole of the sea. Elephant is said to be the slowest breeder, if we start with a single pair, it will produce about 19 lakh elephants in a period of 750 years, if all of them survive. Thus every species produce much more no. of offsprings the environment can support.

ii) **Struggle for existence:-** The individuals increase enormously in no. but the population remains fairly constant due to struggle for food, space and mate among members of same species (inter specific struggle)or with the members of different species (inter specific struggle) and due to natural factors like excessive heat, coal, earthquakes etc. (environmental struggle).

iii) **Survival of the fittest**: - The struggle among the individuals eliminates the unfit (weaker) individuals and fit individuals (stronger) survive.

iv) **Variation:-** Among the population, all the individuals are not alike. Some are more adapted for survival and reproduction in comparison to others.

v) **Natural; selection**:- Those organisms which are more suitably adapted to the environment and possess favorable variations, survive and reproduce. It is called as natural selection (The process in nature by which only the organisms best adapted to their environment tend to survive and transmit their genetic characteristics in increasing no.'s and thus those less adapted tend to be eliminated.

vi) **Origin of new species**: Due to natural selection, the successive generations tend to become better adapted to their environment. Environment is ever changing and it leads to further changes and adaptations in the organisms. As natural selection continues, organisms evolved over a long period of time are distinct from their ancestors and form a new species.

Modern Concept of mechanism of Evolution: Darwin's theory could not explain how variations arise and thus his theory was modified. The modern theory is known as Neo-Darwinism or the synthetic theory of evolution. This theory states that the origin of new species is based on:

1. Genetic variability caused due to to gene mutation, chromosomal mutation and recombination of genes.
2. Reproductive isolation (When members of one species are separated from other members in such a way that they can't mate with them is called reproductive isolation).
3. Natural selection
4. Adaptations for successful survival.

Inherited and Acquired Traits

There are two kinds of traits in every organism:

1. Inherited traits **2. Acquired traits**

1. **Inherited traits:-** These traits are controlled by specific genes and are passed on from one generation to another. Any alteration in the DNA (genes) will be passed on, through germ cells, to the progeny resulting in variations in them. Skin colour, eye colour, form of hair are few examples of inherited traits in human beings. Similarly, height of plant, form of seed, colour of flower etc. are examples of inherited traits in pea plant.

Acquired traits:- Acquired traits are the traits which are acquired by organisms in the life time. Acquired traits are, therefore, not inheritable. They disappear with the death of the individual, e.g., muscular body of an athlete, learning of music.

Speciation:-The process by which new species develop from the existing species due to reproductive isolation of a part of its population is known as speciation.

Mechanism of speciation:- New species are formed when the population of same species splits into two separate groups which then get isolated from each other geographically by the barriers such as mountain ranges, rivers or the seas. The geographical isolation of the two groups of population leads to their reproductive isolation due to which no genes are exchanged between them. However, breeding continues within the isolated population producing more and more generations. Over the generations, the processes of genetic drift and natural selection operate in different ways in the two isolated groups of population and make them more and more different from each other. After thousands of years, the individuals of these isolated groups of population become so different that they won't be capable of reproducing with each other even if they happen to meet again.

Evolution and classification:-

Classification refers to the arrangement of organisms into groups, sub-groups on the basis of similarities/ dissimilarities and placing them in a hierarchy that reveals their relationships.

Characteristics of organisms refer to the details of external and internal appearance or behavior that distinguish them from one another. They include ancestral (basic) and derived characteristics. Ancestral or basic characteristics are present in all members of a population and, thus, form their basic body design. Derived characteristics develop due to evolutionary changes in ancestral characteristics.

There are some some basic characteristics that are shared by most organisms. For instance, body of all animals and plants is formed of microspcopic units called cells. Organisms can be classified into two broad groups i.e., eukaryotes and prokaryotes on the basis whether their cells possess well defined nucleus

and other cell organelles or not. Similarly, eukaryotes can be grouped into unicellular and multicellular orgainisms on the basis of number of cells. Organisms even can be classified into plants and animals on the basis of photosynthetic property. Multicellular organisms can further be grouped on the basis of levels of body organization. For instance, in sponges, cells function more or less independently without organizing themselves into tissues. So, sponges have cellular level of organization. In coelenterates, the cells are aggregated into tissues but the tissues do not form organs. This produces tissue level of organization. From platy-helminthes onward to the most complex chordates, all animals have organ-system level of organization. This gradual change from simple to complex organization is evolution. Moreover, all the organs and organ-systems present in vertebrates show fundamental similarities which point towards common ancestory. Plants also show progressive change from simple to complex body organization supporting evolution.

Evidences that help in tracing evolutionary relationships:-

i) **Evidence from morphology and functional anatomy:** These evidences are based on the similarities in the external and internal features of the different kinds of organisms. These features are:

a) **Homologous Organs:** (Owen 1843) The organs of different species which look different and perform different functions, but have the same basic structure and similar embryonic origin are called homologous organs. The term homologous organ was coined by Richard Owen. For example, the forelimbs of frog, lizard bird and human. They appear quite different externally. In frog, the fore limbs take part in absorbing shock at the time of landing after a leap. In lizard, they help in creeping. In birds they take part in flying. In human begins they are involved in grasping. The forelimbs of all these animals have a similar basic plan of structure. The basic similarity in the fore limbs of these different vertebrates indicates that all these vertebrates had a common ancestor who had five digited or pentadactyl limbs.

Plants also have homologous organs for example a thorn of bougainvillea plant and a tendril of passiflora plant are homologous organs. Reddish and carrot are other examples of homologous organs in plants.

b) **Analogous Organs:** (Owen 1843). The organs which have the same function and are superficially alike but quite different in fundamental structure and embryonic origin are called analogous organs. For example the wings opf an insect and a bird are analogous organs. It is so because both these organs in entirely different animals perform similar functions i.e. they are used for flying in the air. However, they are very different in structure. An insect wing is a fold of membrane which is supported with muscles. On the other hand, wings of a bird are formed of limb bones covered with flesh, skin and feathers. The superficial similarity of these organs is due to adaptation to flying rather than to inheritance from a common ancestor.

c) **Vestigial Organs: -** The organs which are present in reduced form and do not perform any function in the possessor but are fully developed and functional in related animals are called vestigial organs. e.g. tailbone, wisdom tooth, body hair in males, ear muscles, vermiform appendix, nictitating membrane etc. These were fully developed, functional and necessary in ancestral forms. However, these are gradually disappearing in the living forms due to change in their mode of life.

Evidence From Embryology: - It is the study of development of an embryo of organism from fertilized egg to young one. Study of the embryology of different animal groups shows striking structural similarities between them. The early embryos of all the vertebrates resemble in shape and structure. The resemblance of early embryos of fish, salamander, tortoise, chick, rabbit and man is close that it is very difficult to distinguish them from each other. This similarity among the early embryos shows that all the vertebrates have evolved from a common ancestor. Above observations lead Ernst Haeckel to propose a law which is popularly known as the bio genetic law which states that an animal in its individual embryonic development from egg to adult repeats or recapitulates in condensed form the states through which its ancestors have past in the course of their evolution. This law can be briefly put in three words "Ontogeny repeats Phylogeny or Ontogeny recapitulates Phylogeny".

Fossils:-Fossils (L. fossils-dug up) are the remains or impressions of the hard parts of the past organisms in the strata of the earth. They occur in sedimentary rocks, lava and snow. Branch of biology that deals with the study of fossils is called palaentology. Fossils provide a direct evidence of evolution. They are often called written documents of evolution. Fossil record shows that different types of organisms appeared at different times. Many of them became extinct later on but some continued to live in same or modified form.
Fossil history of some animals like horse has been discovered. How birds arose from reptiles has also been found out with the discovery of fossil Archaeopteryx.
Fossils of prokaryotes have been found in older rocks than those of eukaryotes. Invertebrates were formed before vertebrates. In vertebrates fishes appeared earlier than amphibians, amphibians earlier than reptiles, reptiles earlier than birds and mammals. This is how evolution has occurred.
Formation of fossils:-Formation of fossils is called fossilization. Most of the fossils are found in sedimentary rocks, which develop at the bottom of deep lake and sea. Dead bodies of terrestrial plants and animals are brought here by streams, rivers and rain wash. Along with dead bodies of aquatic organisms, they settle down at the bottom where the rate of decay is slow due to absence of oxygen. Sand and silt settle over the dead bodies. Slow decay continues, it leaves only hard parts. Impressions, moulds and casts may be produced if there are no hard parts. Fossils are not necessarily formed in the sedimentary rocks. Land organism have been found preserved in amber (hardened raisin), asphalt (hardened tar), ice, volcanic ash and even in sand dunes
How do fossils form layer by layer
Some 100 million years ago, for instance, some invertebrates had of the sea/ sand. More soil/sand was carried by rain into the streams and rivers and ultimately into th oceans, where it settled at the bottom layer after layer. In the course of time, the layers so deposited changed into rocks (sand stone) due to the presence of the water above and also due to chemical reactions.
Millions of years later, dinosaurs living in the area died and their bodies too got buried in mud. The mud also got compressed into rock in the course of time over the rock containing the earlier invertebrate fossils. Again millions of years later, bodies of horse-like creatures died in the area and got fossilized in rocks above the earlier formed rocks. The rocks formed in this manner at the ocean floor are known as sedimentary rocks. Millions of years later, say, erosion by water flow exposed the horse-like fossils. If we dig deeper, we would come across older and older fossils. We date these rocks or fossils.
Various kinds of fossils have been unearthed from sedimentary rocks. These include many fossil invertebrates (e.g. ammonites, trilobites), fossil fish (Knightia), dinosaur's skull of Rajasanrus (from Narmada valley) etc. The fossils provide direct evidence of evolution.
Palaeotological evidences:(Greek Palaios = old, ancient; antos = being).
Paleontology is the study of past life based on fossil record.
Fossil records show most reliable evidence of evolution. From the study of fossil records following facts have been established:

- The fossils present in the bottom rocks are simple while the most recent fossils found in the upper strata are highly complex. This geological succession agrees with the concept of evolution.
- Some fossils provide a connecting link between two groups. These appear to be intermediate between two large groups of organisms. These are called missing links e.g; fossil bird, Archaeopteryx is a missing link between reptiles and birds.
- Fossil bird shows repetition of characteristics like the presence of teeth in jaws, finger ending in claws, a long tail with tail vertebrae. Bird like characters observed in it are presence of feathers, presence of wings, presence of toothless beak, rounded cranium, etc. The study of Archaeopteryx indicates that birds have evolved from reptile like ancestors.

- Fossil records of certain mammals (horse, elephant, camel and man) if arranged era-wise would present a complete series indicating how their evolution occurred.
- Fossil records also help to known about habit and habitat of the extinct organisms. Some fossil remains are like the organisms living today e.g. cockroach, crab etc. These organisms are well adapted today as they were well adapted in the past.

Evolution by stages

Evolution of eyes:- Eye is a complex organ of sight in animals. Flat worms, Planaria have very simple eyes which are, in fact, just eye-spots to detect light. Even these rudimentary structures in flat worm provide advantage to the animal to ensure its survival. From this basic design, more complex eyes later evolved in different organisms. For instance, eyes in insects, octopus, other invertebrates and all vertebrates including human beings have different structures and also have separate evolutionary origin. The complex structure of eye in these animals has been created in "stages" over many generations. To conclude, the eyes of insects, octopus and all vertebrates are analogous organs which have developed bit by bit over generations in their own way as adaptation for similar function.

Evolution of Feathers:-Fossils also provide us evidence of instances wherein a change useful for one function to start with, can become useful later for quite a different function. For example, feathers were perhaps developed initially to provide insulation in cold weather but later these have become useful for the function of flight in birds. This speculation is based on the evidence from fossil records of small dinosaur. This ancient reptile had feathers but it could not fly using them, thus, suggesting that evolution of feathers had nothing to do with flight. Birds seem to have adapted to flight later using feathers. Since, dinosaurs were ancient reptiles and many of them had also characters of birds (e.g. Archaeopteryx), therefore, these fossil evidences suggest that birds are very closely related to reptiles and have evolved from them.

Artificial Selection:-Artificial selection is the process by which man selects trait (s) useful to him for improving the qualities of domesticated plants and animals.

Man selects the individuals having the desired traits and separates them from those which do not possess such characters. The selected individuals are interbred. This process of artificial selection, when repeated for many generations, produces a new breed with desired traits. In this way, wild forms are modified through artificial selection.

Example. If cows with high milk yield are desired, the animal breeders monitor the milk yield of a large number of cows and select those which produce a large quantity of milk. The calves of the high milk-yielding cows are interbred to get the next generation of calves. After repeating this process for a number of generations, a breed of high milk yielding cow is produced.

Importance of artificial selection

1. By artificial selection, animal breeders have been able to produce improved varieties of several domestic animals such as horses, poultry, goats, cows etc. from their wild ancestors.
2. Plant breeders have obtained improved varieties of useful plants namely wheat, rice, sugarcane etc. Many crop plant species namely cabbage, kohlrabi, kale, broccoli, cauliflower etc have been produced by plant breeders from a common wild mustard species by selective breeding.

In –Text Questions

Q#1 If a trait A exists in 10% of a population of an asexually reproducing species and a trait B exists in 60% of the same species, which trait is likely to have a arisen earlier?

Ans. In asexually reproducing population, there is no reshuffling of traits. New traits do develop due to small inaccuracies produced during DNA copying. They will be in smaller proportion than the traits

already present. Therefore, trait B which exists in 60% of population must have arisen earlier than the trait A which occurs in 10% of the population.

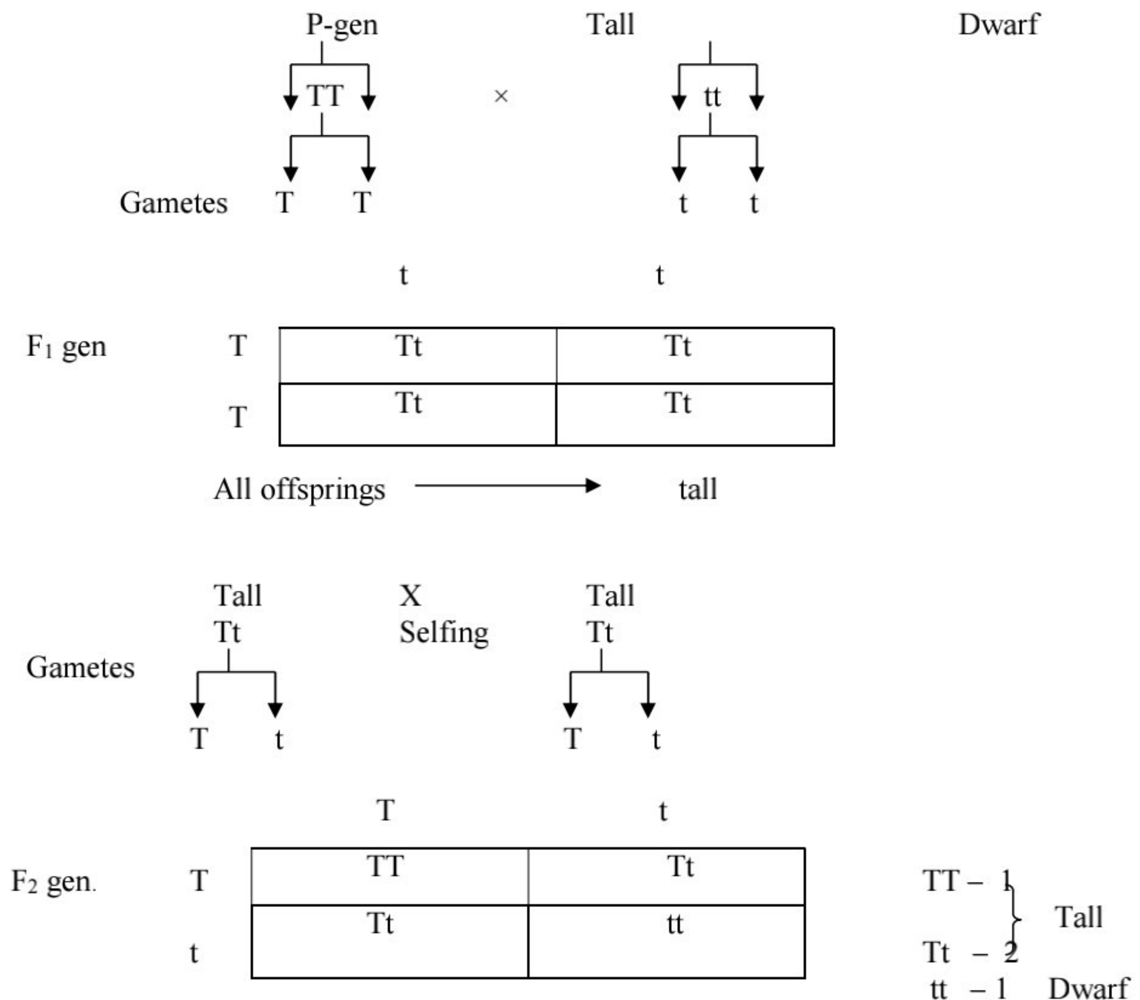
Q#2 How does creation of variation ns in a species promote survival?

Ans. Natural selection plays an important role in selecting the individuals with useful variations in a species. This ensures their survival for example, bacteria with the variation to tolerate heat or green bettles variant formed among red beetles will be selected by nature and will have survival advantage. Thus, creation of variations in a species promote survival.

Q#3 How do Mendel's experiments show that traits may be dominant or recessive?

Ans. When Mendel cross pollinated homozygous tall and homozygous dwarf plants, he observed that in F_1 generation all the plants were tall. When these hybrid plants of F_1 generation were self-pollinated, he observed the tall and dwarf plants appeared in 3:1 ratio in F_2 generation.

Thus, Mendel has proved that the trait which shows its appearance in F_1 generation is the dominant triat and the trait which masks itself in F_1 generation is the recessive trait.



Phenotypic ratio : Tall: Dwarf
3 : 1

Genotypic ratio : TT : Tt : tt

TT : Tt : tt
1 : 2 : 1

Q#4 How do Mendel's experiments show that traits are inherited independently?

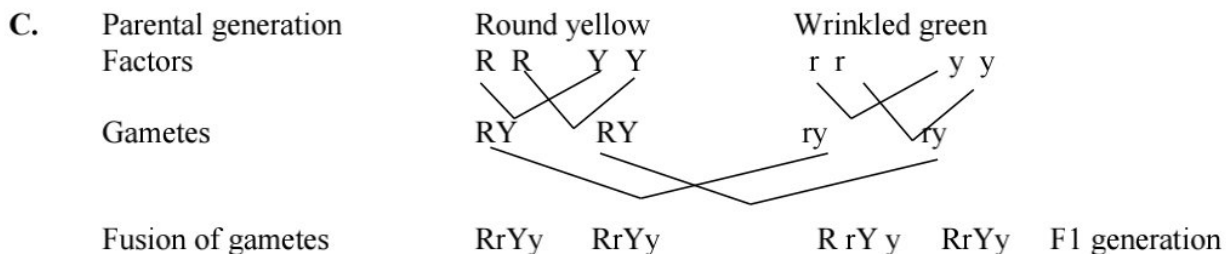
Ans. Mendeles's dihybrid crosses have shown that the gene of each character is assorted or distributed in the gametes independently of the gene of any other character and gets randomly re-arranged in the offspring.

In Mendel's dihybrid crosses, the offsprings of F_1 generation on self breeding produced four types of offsprings. Two types were similar to parents while the remaining two types had combination of traits. This became possible because the genes of the two characters assorted independent to each other.

For example

Mendel crossed pure breeding plants having round and yellow coloured seeds (RRYY) with pure breeding short plants having wrinkled and green coloured seeds (rryy). The plants of F_1 generation were all tall and with rounded seeds (TtRr) indicating that the characteristics of tallness and round seededness were dominant. Self breeding of F_1 yielded plants with characteristics of 9 tall round seeded, 3 tall wrinkled seeded, 3 short round seeded and one short wrinkled seeded. Tall wrinkled seeded and short round seeded plants are new combinations which can develop only if the traits are inherited independently. If the
two traits are considered individually, F_2 ratio would be same as for monohybrid crosses, i.e., 12 tal : 4 short, 12 round seeded: 4 wrinkled seeded.

C.



	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round Yellow	RrYY Round yellow	RrYy Round Yellow
Ry	RRYy Round yellow	RRyy Round Green	RrYy Round yellow	Rryy Round Green
rY	RrYY Round yellow	RrYy Round Yellow	rrYY Wrinkled yellow	rryy Wrinkled Yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled Green

Thus in F_2 generation

Phenotypic ratio: Round Yellow = 9 ; Round Green = 3
Wrinkled Yellow = 3 ; Wrinkled Green = 1

Genotypic ratio

RRYY : RrYY : RRYy : rrYY : RrYy : rrYy : RRyy : Rryy: rryy
1 : 2 : 2 : 1 : 4 : 2 : 1 : 2 : 1

Q#5 A man with blood group A marries a woman with blood group O and their daughter has blood group O. Is this information enough to tell you which of the traits- blood group A or O, is dominant? Why or why not?

Ans. No. The information is not enough to tell whether the trait of the blood group A (I^A) or blood group O (I^0) is dominant. Either can be possible. Each individual carries two alleles. A recessive character appears only when the two alleles are similar.

Possibility 1. Blood Group A is dominant and O Recessive. The trait of blood group O can appear only when both the recessive alleles occur together as in mother and daughter (I^0I^0). A group father should carry both the alleles of A and O ($I^A I^0$).

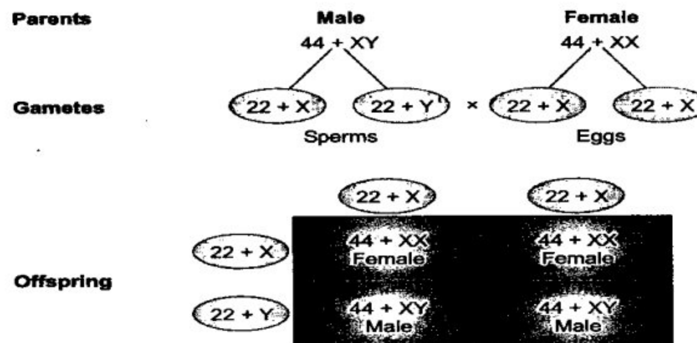
Possibility 2. Blood Group O is Dominant and A Recessive:- In this case the father should carry the alleles of A (I^AI^A) while the mother can be homozygous or heterozygous (I^0I^0, $I^0 I^A$). The daughter will have one dominant alleles of O (I^0I^A).

As both the possibility can occur, the given information is unable to tell whether alleles for blood group A or O is dominant.

Q#6 How is the sex of the child determined in human beings?

Ans. In human beings, sex of the child is determined at the time of fertilization. Human males are heterogametic i.e. they produce two different types of gametes (50% x sperms and 50% y sperms) and human females are homogametic i.e. they produce same type of gametes i.e. ova with x chromosomes.

If sperm having x chromosome fertilizes the ovum with x chromosome, then a female child is produced, and if sperm having y chromosome fertilizes the ovum with x chromosome, then a male child is produced.



Q#7 What are the different ways in which individuals with a particular trait may increase in a population?

Ans. Natural selection, genetic drift and abundance of food are the three major factors responsible for increase in population of individuals with a particular trait. Abundance of food causes easy and frequent reproduction.

Q#8 Why are traits acquired during the life time of an individual not inherited?

Ans. Acquired traits are structural, functional and behavioral changes that an individual develops during its life time due to a particular environment, disease, trauma, use and disuse, conditioning or learning. The traits are not passed on to DNA of germ cells. They remain restricted to somatic cells. They are destroyed with the death of the individual. Therefore, intelligence, experiences and structural acquired

changes cannot pass to the progeny. Weismann (1892) cut the tails of mice for 21 generations but a tail still developed in 22nd generation.

Q#9 Why are the small number of surviving tigers a cause of worry from the point of view of genetics?

Ans. Tigers are surviving in limited numbers. If some natural calamity kills these small population of tigers, they will suddenly become extinct as per genetic drift phenomenon.

Q#10 What factors could lead to the rise of a new species?

Ans. (i) Absence of gene flow amongst subpopulations due to the presence of physical barriers, long distance, differences in habitats, environmental and climatic conditions.

ii) Accumulation of different variations in the different sub-populations of the species.

iii) Natural selections of particular traits in a particular environment.

iv) Genetic Drift: Separation of a small population, changes in its allele frequency, new mutations and adaptations to new habitat.

v) Reproductive Isolation:. Accumulation of different variations and genetic drift result in absence of interbreeding in the previous subpopulations of a species. This results in the formation of a new species.

Q#11 Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not?

Ans. No. Geographical isolation has little role in speciation of self pollinating plant species because there is already no gene flow among members of the species.

Q#12 Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not?

Ans. Recombination of genes is absent in asexually reproducing organisms. Therefore, variations originating in them do not get diluted but spread to all the subsequent generations. Geographical isolation, which helps in speciation, has no role in speciation of sexually reproducing organisms.

Q#13 Give an example of characteristics being used to determine how close two species are in evolutionary terms.

Ans. (i) Closeness of species is determined by presence or absence of fundamental characteristics and correlated characters. Two species of bacteria are closely related as they possess fundamental similarities of occurrence of nucleoid (instead of nucleus), absence of membrane covered cell organelles and presence of 70 S ribosomes. Human beings are close to monkeys because they possess similar eukaryotic multicellular body with vertebrate characters, mammalian traits and primate characters.

(ii) These days DNA matching is undertaken to find out the degree of closeness of the species.

Q#14 Can the wing of a butterfly and the wing of a bat be considered homologous? Why or why not?

Ans. No, it is so because the wings of a butterfly (insect) and wings of a bat (mammal) perform similar functions i.e. they are used for flying in the air, however, they are very different in fundamental structure and embryonic origin. They are analogous organs. The superficial similarity of these organs is due to adaptation to flying rather than to inheritance from a common ancestor.

Q#15 What are fossils? What do they tell us about the process of evolution?

Ans. Fossils are remains or impressions of the past organisms that are found in the rocks of the old ages. They are often called written documents of evolution because they directly indicate the presence of different types of organisms in different ages. The path of evolution is known by arranging the fossils in a proper sequence age-wise. The early fossils are of simple organisms. Later on different complex forms arose, flourished and died down. They were replaced by newer forms. Study of fossils can also indicate the evolutionary stages of organisms. For example, modern horse (Equus) arose from a fossil animal Eohippus that existed on earth 60 million years back as a 30 cm high small animal. It evolved into 60 cm high goat sized Mesohippus about 40 million years back. Mesohippus

gave rise to Merychippus (16 – 18 million years back) that formed Pliohippus (100 – 120 cm high, 10 million years ago). The modern horse evolved only 0.5 million years ago from Pliohippus.

Q#16 Why are human beings who look so different from each other in terms of size, colour and looks said to belong to same species?

Ans. On the basis of time dating, study of fossils and studies involving DNA sequences, it is clear that all humans belong to a single species, Homo sapiens. Two other sub species namely Homosapiens neanderthalensis and Homo sapiens fossilis evolved but disappeared shortly due to geological and climatic changes. Besides, they have capacity of interbreeding I.e. they are reproductively not isolated. Reproductive isolation is must to categorize them as different species.

Q#17 In evolutionary terms, can we say which among bacteria, spiders, fish and chimpanzee have a better body design? Why or why not?

Ans. A better body design in the one which has more complexity, more elaboration and more controls which gives the organism a better competitive edge over others. There is no doubt that out of the four (bacteria, spiders, fish and chimpanzee), chimpanzee has a more elaborate body design or organization. However, since body design is meant for competitive survival in their environment, all the four organisms or for that all living organisms, having a good body design that is suited to their environment.

Chapter End Exercises

Q#18 A Mendelian experiment consisted of breeding tall Pea plants bearing violet flowers with short Pea plants bearing white flowers. The progeny all bore violet flowers but almost half of them were short. This suggests that genetic makeup of the tall present can be depicted as (a) TTWW (b) TTww (c) TtWW (d) TtWw.

Ans. All progeny bore violet flower, so they all must have gene for violet flower. As violet colour appears in hybrids thus it must be the dominant character. So white flowered plant should have ww genes to show recessive white character. It indicates that all progenies got allele W (violet colour) from tall violet flowered plant, thus it's all gametes should have W allele. To serve the purpose, plants must have WW genes. But, tallness was found in 50% progenies, thus half of its gametes contained T gene and other half contained t gene. Inclusively, the tall plant had TtWW genotype.

Q#19 An example of homologous organ is

a) Our arm and a dog's for leg b) Our teeth and elephant tusks
c) Potato and runners of grass d) All the above

Ans. (d) All the above.

Q#20 In evolutionary terms we have more in common with

a) A Chinese school boy b) A chimpanzee
c) A spider d) A bacterium.

Ans. (a) A Chinese school boy is a member of same species i.e. Homo sapiens. It is the environment that has caused some morphological variations.

Q#21 A study found that children with light coloured eyes are likely to have parents with light coloured eyes. On this basis can we say anything about whether the light eye colour is dominant or recessive? Why or why not?

Ans. No. We cannot say with certainty whether the light eye colour is dominant or recessive. But since both the parents as well as the children have light eye colour, the probability is that it is a recessive trait. A recessive trait appears only when an individual possess both the recessive alleles. As the parents are pure for the trait, the children also possess the trait and are pure for the same. Had the light eye colour been a dominant trait, the recessive dark colour trait will have the chance to segregate and appear in some of the children.

Q#22 How are the areas of study, evolution and classification interlinked?

Ans. Classification is based on similarities and differences amongst organisms. The more characteristics two species have in common, the more closely related they are. They must have evolved from a common ancestor. Similarly more differences mean different adaptations and divergence from common ancestor in the remote past.

Q#23 Explain the terms analogous and homologous organs with examples.

Ans. Analogous Organs:-They are organs which have similar appearance and function but are quite different in their origin, development and anatomy.

Examples: - Wings of Butterfly (integumentary outgrowths) and bird (modified fore-limbs).

Homologous Organs:- They are organs which have similar origin, similar development and similar internal structure but have different forms and functions.

Example:- Fore-limbs of Horse, human hand, flipper of whale, wing of bird or bat.

Q#24 Outline a project which aims to find the dominant coat colour in dogs.

Ans.

1. Select two verities of dogs, one with white coat colour, the other with black coat colour.
2. Crossbreed them taking male dog from one variety and female dog from the other variety.
3. Observe the colour of offsprings of F1 generation.
4. Now, bring about breeding among the organisms of F1 generation.
5. Observe the coat colour of organisms of F2 generation and not the varieations in coat colour.
6. Draw conclusions on the basis of study. One of the probable inheritance pattern may be as:

Phenotypic ratio = 3:1

i.e. Black coat colour: white coat colour

3 : 1

Q#25 Explain the importance of fossils in deciding evolutionary relationships.

Ans. Fossils are remains or impressions of past organisms that are found in the rocks. Fossils of lower strata belong to early periods while those of upper strata are of later periods. Arranging the fossils stratum wise will indicate the occurrence of different forms of life at different times. It is found that the early fossils generally belong to simple organisms. Complexity and elaboration increased gradually with evolution. Evolution has never been linear or straight. A number of variants or branches appeared, some of which were more complex while others were less complex.

1. Fossils indicate the path of evolution of different groups.
2. They can indicate the phylogeny of some organisms, e.g., Horse, Elephants.
3. Some fossils have characteristics intermediate between two groups , e.g., toothed bird Archaeopteryx. They indicate how one group has evolved from another.

Q#26 What evidence do we have for the origin of life from inanimate matter?

Ans. Miller and Stanley (1953) assembled an apparatus which had a spark chamber (for producing lightning), a flask for boiling and a condenser. They introduced a mixture of methane, ammonia, hydrogen and water into the apparatus. The gaseous mixture was exposed to electric discharges, condensation and boiling with the temperature kept just below 1000C. The experiment was continued for a few days. At the end of one week, 15% of carbon (from methane) had been converted into simple organic compounds of amino acids, organic acids, sugars and nitrogen bases. It clearly proved that organic compounds or building blocks of life developed from inanimate matter in the remote past when the hot earth was cooling.

Q#27 Explain how sexual reproduction gives rise to more viable variations than asexual reproduction. How does this affect the evolution of those organisms that reproduce sexually?

Ans. Variations arising during sexual reproduction occur due to (i) Chance separation of homologous chromosomes during gametogenesis. (ii) Crossing over between homologous chromosomes. (iii) Chance coming together of chromosomes during fertilization. (iv) Errors or mutations occurring during DNA replication. Only the last method of variations is found in asexually reproducing organisms. The rate of appearance of variations is quite high in sexually reproducing organisms as

compared to asexually reproducing organisms. Therefore, the rate of evolution is also high in sexually reproducing organisms. Their variations are quite viable because most of them are due to reshuffling of genetic material.

Changes in DNA that occur during replication are fewer. Most of them are harmful. They have a negative impact on evolution except when the changing environment finds them useful.

Q#28 How is equal genetic contribution of male and female parents ensured in the progeny?

Ans. Most organisms are diploid. Their genetic material consists of two sets of chromosomes. Gametes carry single set of chromosomes, i.e., they are haploid. Sexual reproduction involves the formation and fusion of two types of gametes, male and female. Male gamete brings one set of chromosomes from the male parent. Female gamete also brings one set chromosomes from the
female parent. When two gametes fuse during sexual reproduction, the normal diploid chromosome complement is restored. It consists of 50% chromosomes from male parent and 50% chromosomes from female parent. Therefore, both the parents contribute equal genetic material to the offspring through formation and fusion of gametes.

Q#29 Only variations that confer an advantage to an individual will survive in a population. Do you agree with this statement? Why or why not?

Ans. It is not always true. The variations that confer an advantage to an individual organism are definitely of more survival valve because natural selection prefers these variations. But there are several other variations which, though donot provide advantage to the organism in the present condition, survive and are inherited to the next generations. Such non-advantageous variations may become advantageous in future when the environmental conditions change.

Mechanism of evolution:
Consider a group of 12 red beetles and assume that they live in bushes with green leaves. They undergo sexual reproduction and consequently generate variations. Imagine, crows eat these beetles. Large number of beetles were eaten up by crows and hence, fewer are available for reproduction.

Consider the following situations:

i) Survival advantage: let us assume that some beetles develop colour variation during reproduction. With course of variations due to sexual reproduction, one beetle acquires green colour instead of red. When green beetle reproduces, it passes the green colour to its offsprings. Crows were not able to see the green beetles on green leaves and hence they were not predated. But, the progeny of red beetles continued to be predated by crows, because they could be easily seen by crows. Hence, only green beetles survived. Green beetles were naturally selected over the red beetles, and this selection was extorted by crows Natural selection: is thus, directing evolution of beetles. Green beetles got adapted in environment much better. We can say that green colour variation became more common due to its survival advantage and got naturally selected.

ii) Suppose another colour variation occurs in beetles and a blue coloured beetle arises accidentally in one generation. In this population, as it expands, there are a few blue beetles, but most are red. Crows see both blue and red coloured beetles on green leaves and eat them. Suppose an elephant comes by and stamps and killed most of the red beetles, while some beetles survived. Now, there occurs accidental survival of blue beetles and frequency of their genes increases, directing towards evolution of beetles. So, in this situation, the colour change gave no survival advantage. Survival of more blue beetles in the population changed the colour characteristic from normal red to blue over a period of time. Had the beetle population been very large, the accident (stamping by an elephant foot) would not have caused such major havoc. In other words, in small populations, accidents can change the frequency of some genes in a population, even if these give no survival advantage to the possessors. This phenomenon is called genetic drift and it provides diversity without any adaptations.

Genetic drift can be defined as change in gene frequency which occurs by chance in a small population.

iii) Let us consider a third situation. As the beetle population starts expanding by sexual reproduction, a plant disease spreads resulting in decrease in the amount of leaf material in the bushes. Expanding population of beetles is now poorly nourished. Consequently, the average weight of adult beetles decreases compared to what it used to be when leaves in the bushes were in plenty. After some time, the plant disease is eliminated. Now, more leaves of bushes are available as food for the beetles. So, the average weight of the beetles would again increase. While considering the third situation, we find that there are two kinds of traits in every organism:
   a) Inherited traits
   b) Acquired traits

a) **Inherited traits:** These traits are controlled by specific genes and are passed on from one generation to another through germ cells are called inherited traits. Any alteration in the DNA will be passed on, through germ cells, to the progeny resulting in variations in them.

b) **Acquired traits:** The traits which are gained during the lifetime are called acquired traits. These cannot be passed to the progeny as these traits influence only somatic cells and not the germ cells. Therefore, even if some of the generations of beetles are low in weight because of starvation, this trait

cannot be inherited by the progeny over generations. Other examples are removal of tail in consecutive generation of mice, pierced ears, lifetime experiences of an individual etc.

Evolution Should Not Be Equated With 'Progress'

Evolution should neither be equated with progress nor with elimination of older, less efficient species. Continuation of old species depends upon the environment. The new species may or may not be better. Formation of new species depends upon the occurrence of physical or reproductive barriers, genetic drift and natural selection that leads to the formation of new population or species which is unable of interbreeding with the original population. Evolution does not proceed continuously in a particular direction.

For example, it is not true that human beings have evolved from chimpanzees. Rather, both human beings and chimpanzees have a common ancestor that lived long time ago. That common ancestor is likely to be neither human nor chimpanzee. The ancestor didn't give rise to modern day chimpanzees and humans in one step. Instead, the descendants of the common ancestor evolved in different directions, giving rise to various forms. One of them formed human, another chimpanzee while some produced great apes.

In fact, there is no real 'progress' in the idea of evolution. Evolution is simply the generation of diversity and the shaping of the diversity by environmental selection. The only progressive trend in evolution seems to be that more and more complex body designs have emerged over time. However, again, it is not as if the older designs are inefficient. Many of the older and simpler designs still survive. In fact, one of the simplest life forms- bacteria-inhabit the most inhospitable habitats like hots springs, deep-sea thermal vents and the ice in Antarctica. In other words, human beings are not the pinnacle of evolution, but simply yet another species in the teeming spectrum of evolving life.

Thus, there is no such thing as ladder of progress but there are branches from the family tree of species.

Human Evolution

- Carolus Linnaeus called humans Homo sapiens (Wiseman).
- Charles Darwin published his idea about man's ancestry in the book 'The descent of man'.

Anthropology: It is the comparative study of human beings and their interactions with each other and the environment.

- The human evolution can be studied with the help of evolutionary tools such as fossils, time-dating and determining DNA sequences. There is a great diversity of human forms and features across the earth. All human beings have same genetic composition i.e. same DNA content, hence belong to same species though are different in terms of size, colour, looks etc.

- Recent evidences on genetic basis, clearly indicate that origin of man occurred in Africa from there, human species spread to different regions i.e. West Asia, then to Central Asia, Eurasia, South Asia, East Asia, followed by Australia and America. Like all other species, humans are also the result of evolution. They are not considered as pioneers of evolution, but a part of evolution.

Types of Variations

Broadly speaking, variations are of two types.

i) Somatic variations
ii) Germinal or genetic variations

i) **Somatic variations:-** These variations affect the somatic or body cells of the organism. These variations are non-inheritable and disappear with the death of the individual e.g. if an individual possesses six fingers in his/her hand, it is not necessary that his/her offspring will also inherit the same character.

ii) **Germinal or genetic variations**:- These variations are produced in the germ cells of an organism and are inheritable. They may be already present in ancestors or sometimes develop due to mutation during life time of an organism e.g. height and eye colour are examples of genetic variations.

Our Environment

Environment:- It is derived from French word "environ" meaning to encircle or to surround. It is defined as the physical and biological world where we live. It includes everything around the organism i.e. both non-living (abiotic) and living (biotic) components. The abiotic components are the physical factors such as climatic factors (e.g. temperature, light, wind, humidity etc) and edaphic factors (e.g. soil texture, topography, pH etc). This interdependent interaction among organisms as well as with the abiotic components maintains a balance in nature.

Ecosystem:-The term ecosystem was proposed by A.G. Tansley in 1935. The term ecosystem comprises of two words "Eco" and "System" – Eco meaning environment and system meaning a particular way. Thus, ecosystem means the particular way in which the environmental components are related to one another.
"Ecosystem may be defined as a structural and functional unit of biosphere comprising living and their non-living environment that interact by means of food chains and chemical cycles resulting in energy- flow, biotic diversity and material cycling to form a stable, self-supporting system.
There are two basic processes involved in an ecosystem:

i) **Cycling of material**:- It is a cycle of exchange of materials between living beings and the environment to maintain continuous supply of these materials to living beings for stability of life on earth. These cycles are called as biogeochemical cycles.

ii) **Flow of energy**:- The energy trapped by green plants from sun is passed on to the other organisms of the food chain.

Classification of ecosystem:
In the biosphere, ecosystems may be classified on the basis of their nature, duration and size.

A. **Nature:** On the basis of nature, ecosystems may be classified as
   1. Natural ecosystem
   2. Artificial ecosystem / Manmade or anthropogenic ecosystem

1. Natural Ecosystem
These ecosystems operate in the nature by themselves without any human interference. E.g. a pond, a lake, meadow etc.
On the basis of kind of habitat it provides to the organisms, natural ecosystem is of two types:
1) Aquatic Ecosystem 2) Terrestrial Ecosystem

1) Aquatic Ecosystem:- It is that type of ecosystem in which habitat is provided by water. E.g rivers, lakes etc. On the basis of salinity, aquatic ecosystem is further divided into three types:
   a) Fresh water Ecosystem:- It is a type of aquatic ecosystem in which salinity is low e.g. ponds, lakes, etc.
   On the basis of state, either standing or moving, fresh water ecosystem is of two types:
      i) Lotic ecosystem:- It is that type of ecosystem in which water is moving e.g. rivers, streams.
      ii) Lentic ecosystem:- It is that type of ecosystem in which water is standing e..g ponds, lakes.

   a) Marine Water Ecosystem:- It is a type of aquatic ecosystem in which salinity is high e.g. Seas, Oceans, etc.
   b) Estuarine water Ecosystem:- It is a type of aquatic ecosystem which is formed by intermixing of fresh water and marine water. It has salinity within a range of 0.5-3.5%.

2) **Terrestrial Ecosystem:-** Habitat provided by land is termed as terrestrial ecosystem. It varies greatly in climatic and biological terms. The desert, grassland and mountain represent the terrestrial ecosystems (land-based ecosystems).

It is of three types:
i) Grassland
ii) Desert
iii) Forest

- **Artificial Ecosystem:-** These are maintained by man and hence are also termed man-made or man-engineered ecosystems. In these ecosystems, man maintains or disturbs the natural balance e.g. croplands, gardens, aquarium etc.

B. Duration:- On the basis of duration, ecosystems are classified into two types:
i) Temporary ecosystems
ii) Permanent ecosystem

i) **Temporary ecosystem:-** These are short-lived ecosystems which may be natural or man-made e.g. rain fed pond, laboratory culture of protozoans.

ii) **Permanent ecosystem:-** These are self supporting natural ecosystems that maintain themselves for relatively long duration e.g. a lake, a forest, a desert etc.

C. Size:- On the basis of size, ecosystems are classified into two types:
1. Small ecosystem
2. Large ecosystem

1) **Small ecosystem**:- Small sized ecosystems are also termed micro ecosystems e.g. a flower pot, a site under a stone, etc.

2) **Large ecosystem:-** Very large sized ecosystems are also termed macroecosystems, e.g. ocean, forest, desert, etc.

Components of an Ecosystem

Every ecosystem has two main components:
Abiotic components
Biotic components.

Abiotic components

These are non-living physio-chemical components of an ecosystem. These components not only affect the distribution and structure of organisms but also their behavior and inter-relationships. These factors are of three types:

a) **Climatic factors:-** These include water, sunlight, temperature, humidity, rainfall, wind and

b) **Inorganic substances**:- These include carbon, nitrogen, oxygen, sodium , potassium , calcium, phosphorous etc. and their compounds (water , carbon dioxide). These occur either in the free state in air or dissolved in water in the soil.

c) **Organic compounds:-** These include carbohydrates , proteins , lipids, nucleic acids etc. These are present in living organisms and dead organic matter.

d) **Edaphic factors**:- Include all the factors related to the structure and composition of the soil, including its physical and chemical properties.

e) **Topographic factors:-** Include factors related to physical features of the earth like slope, valley, mountain, plain, etc.

Biotic components. The biotic component of an ecosystem is a community of living organisms (like plants, animals and microbes). The biotic community of an ecosystem includes the organisms that fall into three nutritional groups.

Producers (or autotrophs): They are photosynthetic or autotrophic plants which are able to synthesize organic food such as starch from inorganic substances, carbon dioxide and water in presence of chlorophyll and sunlight. This process is called photosynthesis. They convert solar energy into chemical energy so are also called as transducers.. For example, green plants blue green algae, some bacteria and free floating autotrophic micro-organisms (Phytoplanktons).

Importance of Producers

i) All organisms depend upon the producers for organic food.
ii) They pick up carbon dioxide (CO_2) from the atmosphere and release oxygen during the process of photosynthesis.
iii) Producers maintain the $CO_2 – O_2$ balance in the nature.

Consumers (or heterotrophs): They are the animals which feed on organic food prepared by autotrophs. Consumers are differentiated into three broad categories-herbivores, carnivores and omnivores.

a) **Herbivores** obtain their food and energy directly from green plants (autotrophs). Herbivores are also called first order consumers or primary consumers. As the herbivores feed on plants or plant products and convert them into animal matter, they are often called key industry animals. For example, rabbit, mouse, squirrel, grasshopper, goat, cattle, ete. are herbivores.

b) **Carnivores, Secondary or second order consumer:-** ingest or prey upon other animals. The carnivores which feed on the flesh of herbivores are named as primary carnivores or secondary consumers. e.g., cats, dogs, foxes, frogs, small fish, etc.

c) **Tertiary or third order consumers:-** These are larger carnivores which feed on primary carnivores (secondary consumers). These are termed as secondary carnivores or tertiary or third order consumer e.g. large fish, water birds, snakes, wolves etc.

d) **Quaternary or fourth order consumers**:- These are even larger carnivores which feed on secondary carnivores (tertiary consumer). These are mostly top carnivores. e.g. tigers, lions, eagles, hawks, sharks, crocodiles, etc.
In any food chain, the consumer present at the end of the chain is called top carnivore.

e) **Omnivores** :- These are the organisms which feed on both plants and animals e.g. humans, dog, crow, etc.

f) **Parasites**:- These are the organisms which obtain their food from other organisms e.g. tapeworm, certain parasitic fungi like albugo etc.

Importance of consumers

i) They provide the biological control over the population of producers at different levels of consumers
ii) Many consumers help the producers in pollination and fruit dispersal.

Decomposers and transformers (Reducers): They are saprophytic micro-organisms which feed on dead bodies of organisms and organic wastes of living organisms, for example, certain bacteria and fungi. They break down the complex organic compounds present in the dead organisms into simpler substances. Through the decomposers, the simple small organic molecules are utilized by decomposers themselves and inorganic substances are released into the environment for reuse as raw materials by the producers.

Transformers:- There are special group of bacteria which disintegrate the simple organic substances into inorganic forms which are suitable for reuse by producers by a process called mineralization.

Importance of Decomposers

i) Decomposers help in decomposing the dead bodies of plants and animals, and hence act as cleaning agents of environment.
ii) They create space for the newer generation of organisms.
iii) Decomposers return the chemical nutrients to the environment by decomposing the dead bodies of plants and animals.
iv) They maintain the fertility of soil.

Functions Of Ecosystem:-

Ecosystem regulates the equilibrium of the nature by maintaining a cyclical pathway for exchange of materials as:

i) Solar energy is trapped by autotrophic organisms.
ii) The autotrophic organisms prepare organic food constituents with the help of solar energy by taking raw materials from the environment.
iii) These organic materials are used by heterotrophic organisms as food.
iv) Some of the materials are returned to the environment in the form of excreta while the rest is returned to the environment when they die.
v) The dead body of an organism is decomposed by a certain group of organisms known as decomposers.

Trophic levels:-

1. The series of organisms taking part at various biotic levels form a food chain. Each step or level in a food chain where transfer of energy takes place is called trophic level.
2. A food chain usually consists of 2-5 trophic levels in a terrestrial ecosystem and 4-5 trophic levels in an aquatic ecosystem.
3. In any food chain, producers (green plants) fix the solar energy and manufacture their own food by the process of photosynthesis and release oxygen. Thus, green plants constitute the first trophic level (T_1) i.e. the producer level and are called primary producers.
4. Green plants or plant products are then eaten by herbivores, so they constitute the second trophic level (T_2) and are called primary consumers e.g. grasshopper, rabbit etc.
5. Herbivores inturn are eaten by primary carnivores, which constitute the third trophic level (T_3) and are called secondary consumers e.g. frog, fox etc. These secondary consumers, inturn are eaten by secondary carnivores e.g. kingfisher, hawk etc which are called tertiary consumers. The latter constitute the fourth trophic level (T_4) and so on.
6. The last trophic level is always that of decomposers.

Food chain:

In the environment, food relationships exist between different living organisms. They interact with one another for their food preparation as well as food consumption. Some organisms consume other organisms and they are inturn consumed by others thereby forming a chain. In

this chain, energy transfer takes place, and it is called a food chain. A food chain can be defined as follows:
The sequential interlinking of organisms involving transfer of food energy from the producers, through a series of organisms with repeated eating and being eaten, is called food chain.

Solar energy
↓
Producers
↓
Primary Consumers
↓
Secondary Consumers

Tertiary consumers
↓
Top Consumers

Length of food chains:- In ecosystems, different food chains may have two, three, four or maximum five trophic levels. Accordingly, a food chain may end at the i) herbivore (primary consumer) level, ii) Primary carnivore (secondary consumer)level, iii) Secondary carnivore (tertiary consumer) level or iv) Tertiary carnivore (quaternary consumer) level. First trophic level in all of these food chains will be the producers.

Tertiary carnivore		Tiger	Eagle	Tiger	
Secondary carnivore			Snake		Fish eating bird
Primary carnivore			Frog	Wild cat	Small fish
Herbivore	Elephant	Deer	Grasshopper	Rabbit	Aquatic insect
Producers	Plants	Grasses	Grasses	Grasses	Aquatic plants

Types Of Food Chain:

i) **Grazing food chain or predator food chain:-** It begins at the producer level and extends upto top carnivores. Usually the size of the consumer is comparatively large at successive levels. Some examples of predator food chains in various ecosystems are:-

a) **In the forest:**

Grasses → Aphids → Birds

b) **In the garden**:

Grasses → Grasshoppers → Frogs → Snakes → Vultures

ii) **Parasitic Food Chain:-** It also begins with the producer level. Unlike the predator food chain, here the consumer is smaller in size. Passing of food energy from larger to smaller organisms is the characteristics feature of this food chain. A larger organism from which food is derived is called the host. Smaller organism which obtains food is called the parasite.

iii) **Saprophytic / Detritus Food Chain**:- Some animals regarded as top carnivores like hawk, lion, vulture have no natural food enemy. They are seldom killed for eating yet their dead bodies are acted upon by decomposers. The transfer of food energy from dead organic matter of decaying animal and plant bodies to micro organisms is known as saprophytic food chain.

Examples of Food Chains

A food chain operating in grassland or a forest is:

Grass (Producer) → Deer (Herbivore) → Lion (Carnivore)

In this food chain, grasses represent the producers (first trophic level). Grasses synthesize their own food by the process of photosynthesis. Grasses are eaten up by deer, which represent the herbivores or the primary consumers. Deer inturn are consumed by lions, the carnivores or the secondary consumers.

A food chain in grassland which has four steps is:

Grass (Producer) → Insect (Herbivore) → Frog (Carnivore) → Eagle (Secondary carnivore)

In aquatic food chains, phytoplankton's act as producers, while zooplanktons feed on phytoplanktons a food chain operating in an aquatic ecosystem (in pond or a lake) is:

Algae (Producer) → Zooplankton (Herbivore) → Small fish (Small carnivore)

Big fish (Big carnivore)

Another aquatic food chain is:

Algae (Phytoplankton) (Producer) → Protozoan (Zooplankton) (Herbivore) → Fish (Carnivore I)

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Fish (Carnivore I) → Squil (Carnivore II) → Seal (Top carnivore)
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Characteristics of food chain:-

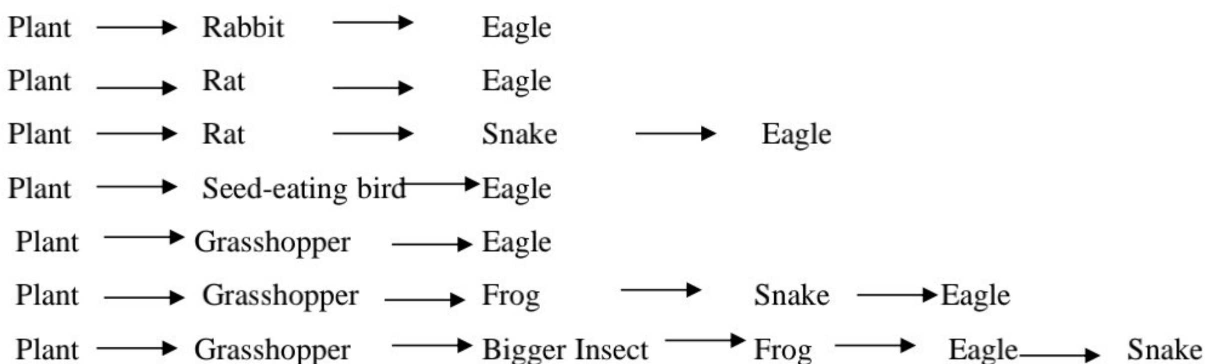
1.A food chain involves a nutritive interaction between the living organisms of an ecosystem. In a food chain, there occurs repeated eating i.e. each group eats the other group and subsequently is eaten by some other group of organisms.
2. A food chain is always straight and proceeds in a progressive straight line.
3.There is unidirectional flow of energy from sun to producers and subsequently to series of different types of consumers.
4.Usually, there are 3 or 4 trophic levels in a food chain. In a food chain, there may be maximum of trophic levels.
5.Some organisms are omnivores. These occupy different trophic positions in different food chains.
6.At each transfer, generally 80-90% of energy is lost as heat in accordance with second law of thermodynamics.

Significance of Food Chain

❖ The study of food chains helps in understanding various organisms in an ecosystem.

❖ The food chains transfer energy and materials between various living components of an ecosystem or biosphere.
❖ The food chains give dynamicity to an ecosystem or biosphere.
❖ The movement of toxic substances like pesticides, weedicides, etc., through food chains can prove very harmful as they enter the bodies of organisms and go on concentrating at each trophic level. This phenomenon is called biomagnifications or biological magnification.

Food Web:-The various food chains, operating within an ecosystem or the biosphere cannot function in isolation. Many of these food chains are interconnected by organisms which are a part of more than one food chain. Thus, various food chains form a 'network with interconnections and linkages.
The interlocking pattern of several food chains is known as food web.
Thus, food web may be defined as a network of food chains which become interconnected at various trophic levels so as to form a number of feeding connections among different organisms of a biotic community.
In a food web, one organism may occupy position in more than one food chain. An organism can obtain its food from different sources and inturn may be eaten up by different types of organisms. For example, a rat may be consumed by a snake or an eagle. Similarly, a grasshopper may be consumed by a frog, an eagle or a bigger insect. This food web has seven interconnected food chains. These are;



Characteristics of food web:-

i. Food webs are never straight. Instead, each food web is formed by interlinking of food chains.
ii. A food web provides alternative pathways of food availability.
iii. Greater alternatives available in a food web makes the ecosystem more stable.
iv. Food webs also help in checking the overpopulations of highly fecundive species of plants and animals.
v. Food webs also help in ecosystem development.

Flow (Transfer) Of Energy In AN Ecosystem

Each organism needs energy to carry on vital activities, and for building up and repairing the body tissues.

- The ultimate source of entire energy, used by living organisms, is the sun.
- Of the total solar radiations falling on the earth, only about 1% are captured by green plants in a terrestrial ecosystem and converted into food energy by photosynthesis. This energy is stores as chemical energy of food. The plants utilize part of this stored energy for their metabolic activities such as respiration, growth etc. During metabolic activities, some energy is released in the environment as unusable heat energy.
- Since, amount of available energy goes on decreasing at each trophic level, food chains usually consist of only 3 or 4 steps and rarely maximum of 5 steps.
- In an ecosystem, generally, the producers are maximum in number. As we move along the chain, the number of individuals at each trophic level decreases.

Ten Per Cent law

It was put forth by Lindeman (1942). It is also termed as second law of thermodynamics or law of entropy.

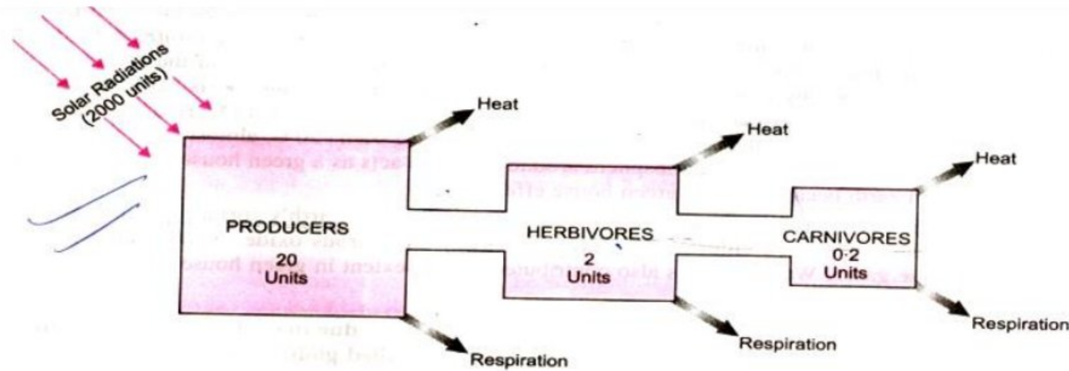
This law states that during transfer of energy from one trophic level to the next level, only about 10% energy is available to the higher trophic level and the remaining 90% is lost in respiration and heat.

Thus, according to this law, transfer of energy from one trophic level to other trophic level is never 100 per cent. On an average, about 10% of energy is actually available to the next trophic level.

In every food chain, transfer of energy is unidirectional and it follows the 10 per cent law at each trophic level, which, in simple words, means that the energy available at each successive trophic level is 10 per cent of the previous level. For instance, 2000 unit (Joules) of solar energy falls on a tract of land having vegetation. Plants absorb about 1% of incident solar radiations. Thus, about 20 units of energy is trapped by them and converted into chemical energy. The remaining energy is lost to the environment. According to 10% law, only 2 units of energy is steored in the flesh of herbivores which have consumed stored energy of plants. The remaining 18 units of energy got lost to the environment during transfer of food energy and respiration of herbivores. In the same way, carnivores would store only 0.2 unuts of energy in their flesh by consuming herbivores.

Energy Flow Diagram

If we critically examine the energy flow diagram, two things become clear:



i) **Unidirectional Flow of Energy:-** There are unidirectional flow of energy from sun to producers, and from producers to various levels of consumers. The energy captured by the producers does not revert back to solar input. Similarly, the energy which passes to herbivores does not come back to producers. As it moves progressively through various trophic levels, it is no longer available to the previous level.

ii) **Biological Magnification:-** Second interesting feature is that some harmful non-biodegradable chemicals (pesticides, e.g. D.D.T. and heavy metals such as mercury, arsenic, cadmium etc.) enter the bodies of organisms through the food chains and go on concentrating at each trophic level. This phenomenon is called **biomagnifications or biological magnification.**
The phenomenon that involves progressive increase in concentration of harmful non-biodegradable chemicals at different trophic levels in a food chain is called biomagnifications.

- **How Do Our Activities Affect The Environment?**
The human beings are an integral part of the environment. Changes in the environment affect human beings and human activities to bring changes or create problems in the environment around them. These problems are solid wastes and their disposal and depletion of the ozone layer.

Solid Waste Management
In our daily life, we generate a lot of materials and throw them away. The useless left over or discarded materials are termed as wastes. The waste materials can be gaseous (e.g., automobile exhausts, smoke from chimneys of industries and houses), liquid (e.g. effluent from industries, sewage water) or solid (e.g. food waste, cow dung and human excreta, etc,. Solid wastes, in particular, get accumulated in the environment for shorter or longer duration. These are the main sources of soil pollution.

Solid Wastes
Solid wastes generally come from residences, vegetable and fruit markets, cattle sheds, industries, agricultural fields; and many other places. Solid wastes include peelings of fruits and vegetables, other kitchen waste, ash, paper, cow dung, human excreta, glass, plastics, leather and rubber articles, brick, sand, worn out clothes, metal objects etc. These different kinds of solid wastes can be conveniently categorized into following categories:

i) Food waste:- It includes waste of vegetable and fruit markets and kitchens (e.g.; rotten/ left over vegetables and fruits and their peels), waste of slaugher houses and food canning industries.
ii) Cow dung, Human Excreta and Farm waste.
iii) Trash and Rubbish:- It includes dirt, ash, sand and bricks; polythene bags and plastic waste; broken/ useless boards, card boards and waste paper; waste rubber, and leather articles; waste/ broken glass articles; wornout clothes and metal articles etc.

iv) Solid waste from chemical and other industries.

v) Hospital waste:- It includes used cotton, bandages, used /broken syringes and needles, used plastic or glass bottles etc.

When accumulated, these heaps of solid wastes make the surroundings dirty and pollute the soil.

Biodegradable and Non-biodegradable Solid Wastes

Solid wastes that accumulate in the environment due to human activities can be categorized into two types:

1. Biodegradable wastes
2. Non-biodegradable wastes

1. **Biodegradable wastes:-** These include substances such as household garbage, human urine and faecal matter (sewage), agricultural residues, cattle dung, wood, paper, cloth, hay, cotton, jute, tea leaves, cake, flowers, leaves, wool and several industrial wastes. All these substances can easily be degraded by natural means (i.e., by the action of microorganisms such as bacteria and fungi of decay) into simpler, harmless substances in due course of time, Micro-organisms such as bacteria and fungi of decay are present in abundance in our environment (air, water and soil). These secrete specific enzymes. The enzymes breakdown complex organic substances (present in biodegradable wastes) into simpler, easily dissolvable substances. The latter reach the reservoir pool (air, water or soil) and are again available to autotrophs for photosynthesis.

- **Harmful effects of biodegradable wastes:**
- Biodegradable substances act as pollutants only when their quantity becomes large and they are not broken down into simpler substances by the action of micro-organisms at the right time.
- These affect the human life in various ways:

i) Decomposition of biodegradable wastes results in the production of foul smell which spreads to surrounding areas and makes the life miserable.

ii) Flies breed at huge heaps of solid wastes containing biodegradable substances, carry the germs and spread diseases such as diarrohoea, typhoid, tuberculosis, cholera, conjunctivitis etc.

iii) These biodegradable wastes may also block the drains, creating pools of water which become the breeding sites of mosquitoes. The latter are the carries of diseases like malaria and dengue.

iv) Dumping of industrial wastes reduces the fertility of the soil leading to reduction in crop yields.

2. **Non-biodegradable waste**:- Wastes that cannot be degraded by natural means, i.e., by the actions of micro-organsims, into simpler, harmless substances in due course of time. Only physical processes such as heat and pressure can affect such type of waste substances. Some familiar non-biodegradable waste substances are plastic objects, ball-point pen refill, synthetic fibres, glass objects, pesticides (e.g.; D.D.T.), industrial chemicals and heavy metals (mercury, lead, arsenic, cadmium etc.), metal articles (iron, nails, aluminium cans, silver foil etc.), radioactive wastes etc. Polythene bags are also non-biodegradable. These non-biodegradable substances may occur in the environment in gaseous, liquid or solid form.

- **Harmful effect of non-biodegradable wastes:**

1. Some of the non-biodegradable substances such as pesticides (e.g.' D.D.T.), industrial chemicals, heavy metals, and radioactive substances are very harmful. This is so because these enter the food chains and their concentration goes on increasing from one trophic level to the next. Human beings occupy the top level in any food chain, the maximum

concentration of these chemicals get accumulated in our bodies. As a result of biomagnifications, these result in many harmful effects in human beings and other animals.

2. Excessive use of fertilizers and pesticides, and dumping of industrial chemical wastes affects the soil fertility and subsequently reduces the crop yield. The soil, thus, may become acidic or alkaline.

Modes of Waste Disposal or Managing the garbage we produce:

'Waste disposal' literally means 'getting rid of waste'. Disposal of waste should be done scientifically. The method of waste disposal depends on the nature of the waste.

Some prominent methods of waste disposal are:

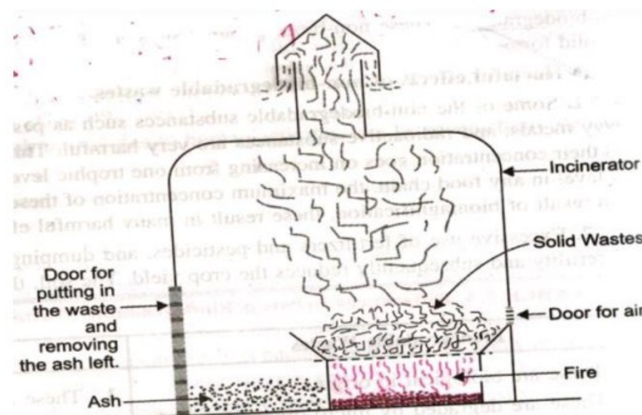
1. Land fills
2. Recycling of wastes
3. Preparation of compost
4. Incineration or burning at high temperature
5. Production of biogas and manure.

1. **Landfills:-** In urban areas, majority of the soil wastes are buried in low lying areas to level the uneven surface of land. This method of waste disposal is commonly called land fills.

2. **Recycling of wastes:-** Number of solid wastes (paper, plastics, metals, etc.) can be recycled by sending them to respective recycling units. For instance, paper is sent for recycling into special paper mills. Industrial wastes are treated in special plants where valuable wastes are recycled. Certain wastes are mixed to generate useful materials. For instance, molten plastic is mixed with asphalt and the material is used for making roads.

3. **Preparation of compost:-** Household waste such as peeling of fruits and vegetables, left-over food, fallen dead leaves of kitchen garden plants and potted plants etc. can be converted into compost and used as manure.

4. **Incineration or burning at high temperature:-** Incineration is the process of burning of substances at high temperature (usually more than 1000^0C) and ultimately converting them into ashes. It is carried out in an incinerator. Household waste, chemical waste and hospital waste are generally disposed of by incineration process. In fact, bulk of waste is removed by this technique. Burning of waste at a very high temperature generates carbon dioxide and water vapours, which escape into the environment and only the ash is left behind.
   This ash can be disposed of by landfills.



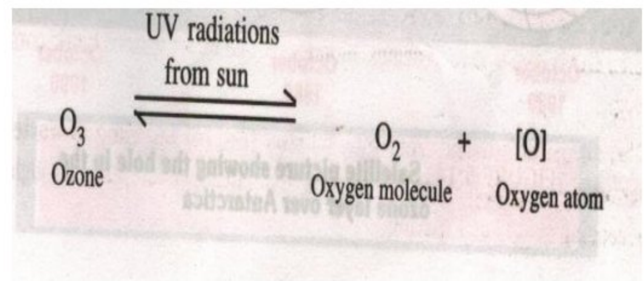
5. **Production of biogas and manure:-** Biodegradable wastes can also be used in biogas plants to generate biogas and manure. Biogas is a cheap source of fuel, and manure, a cheap fertilizer.

6. **Pyrolysis:-** Destructive distillation of the combustible constituents of solid wastes at high temperature (650-1000^0C) so as to recover the chemical constituents and chemical constituents and chemical energy of organic wastes.

Ozone Layer And Its Depletion

Ozone layer

Ozone is a form of oxygen. It is a triatomic molecule made up of three atoms of oxygen, O_3. Ozone is highly poisonous. Very little quantity of ozone is present in the lower part of atmosphere, called troposphere some 18-50km above poles. Though ozone is present throughout the stratosphere. This rich zone of ozone in the stratosphere is called ozone layer or ozonosphere. It is also commonly called ozone shield.



In the stratosphere, ozone is being photo dissociated and generated simultaneously by the absorption of harmful ultraviolet (UV) radiations coming from the sun:

The two reactions (photodissociation of O_3 and its generation) are in equilibrium thereby maintaining steady concentration of ozone in the strastsphere some 18-50km above sea level. Ozone layer is commonly called ozone blanket. Ozone layer in the stratosphere acts as a protective shield to protect all types of life from the harmful effects of UV radiations.

Ozone Depletion:- The thinning of ozone layer is commonly called ozone depletion. Ozone is being depleted by air pollutants. Chlorofluorocarbons (CFCs) are air pollutants that are mainly responsible for the depletion of ozone layer in the strastosphere. Besides, methane (CH_4) and oxides of nitrogen (NO_x) also cause destruction of ozone.

Ozone Hole:- Decline in thickness of ozone layer over a restricted area is called ozone hole. Ozone hole was first discovered over Antarctica in 1985.

Amount of atmospheric ozone is measured by Dobson spectrometer and is expressed in Dobson unit.

Ozone Depleting Substances (ODS)

These are the substances which react with the ozone layer in the stratosphere and destroy it. The main ODS are chlorofluorocarbons, halons, methane, nitrous oxide, carbon tetrachloride and chlorine. Of these, chlorofluorocarobons are the principal ODS . jet and rockets release some ODS in the stratosphere while others slowly enter from the troposphere into the stratosphere.

Effects of Ozone Depletion

The thinning of ozone layer allows more UV radiations to pass through it which then strike the earth. These cause following harmful effects on man, animals and plants:

i) **Cancers:-** UV radiations increase incidences of skin cancer and herpes.

ii) **Eye Sight:-** UV radiations cause damage to eyes resulting in dimming of eye sight, photo burning as well as increased incidences of cataract in eyes.

iii) **Immune System:-** UV radiations cause damage to immune system and hence lowering the body's resistance to diseases.

iv) **Increased Embryonic Mortality:-** Harmful UV radiations would increase mortality of developing embryo's in the mother's uterus.

v) **Photosynthesis:-** UV radiations would result in 10-25% decline of photosynthesis in plants.

vi) **Global Warming:-** Decreased photosynthesis would result in increase in the concentration of CO_2. This will result in global warming.

Preventive measures:-

1. Use alternative sources of energy instead of fossil fuels.
2. Use of CFC's in refregirators and air conditioners should be banned. Rather, CFC's should be replaced with alternatives such as hydrofluoro carbons (HFC's) and hydrochloroflouro carbons (HClF's).
3. The products which contain chlorine and harmful ozone depleting chemicals should be banned.
4. Use of eco-friendly biopesticides, bioinsecticides etc instead of chlorinated insecticides and pesticides to control various pests and diseases.
5. Increase public awareness about the issue.

International Efforts to Check Ozone Depletion

The thinning of ozone layer was noticed in 1980s. A spring time ozone hole was discovered over Antarctica in 1985 by Farman and coworkers. The hole continued increasing in diameter over the years. A small ozone hole has also been discovered over North Pole. These findings forced the environmentalists to develop effective strategy to check the thinning of ozone layer.

i) **Montreal Protocol:-** In 1987, the United Nations Environment Programme (UNEP) succeeded in forging an agreement between nations to limit CFCs production to half the level of 1986. It was also decided that all the signing nations would take necessary steps to decrease the use of all ODS, particularly chlorofluorocarbons (CFCs). It was also recommended that alternate technology will be developed to replace the use of CFCs. This agreement is called Montreal Protocol.

ii) **Helsinki Declaration**: In 1989, majority of the nations pledged to phase out chlorofluorocarbons by the year 2000. Productions of CFCs have been stopped since then and CFCs have been replaced with hydrofluorocarbons (HFC) and hydrochlorofluoro carbons (HCIFC). September 16 is celebrated as International Day for the preservation of ozone layer.

iii) **Earth summit**:- It was organized by UNCED (United nations conference on environment and development) at Rio de Janeiro, Brazil in 1992. The aim was to reduce the emission of greenhouse gases.

iv) **Kyoto protocol (1997):-** An International conference was held in Kyoto, Japan which obtained commitments from different countries for reducing overall greenhouse gas emission at a level 5% below 1990 level by 2008 – 2012.

Global warming:-

Green house effect:- It is the warming effect found in a green house which allows solar radiations to pass in but prevents long wave heat radiations (infra red radiations) to pass out due to the presence of glass panes, water vapours and carbon dioxide.

Only 48% of solar energy reaches the surface of earth. 52% of solar energy is filtered out or scattered by the constituents of the atmosphere e.g. clouds, dust particles, water vapours and gases. Only 1% of solar energy reaching the earth is picked up by plants. Most of the remaining energy is used up in warming the surface of earth. A part of it is reflected back into the atmosphere from the surface of land and water.

Heat absorbed by the surface of earth during daytime is emitted back into the atmosphere in the form of infra red radiations. A part of these radiations passes out of the atmosphere and the remaining radiations are absorbed by greenhouse gases and re-emitted in all the directions including back to the earth. It is called green house effect.

Green house gases (GHGs):- These are those gases which allow the short wave radiations to pass through but absorbed the long wave heat (infra red) radiations, reflected back from earth surface. Main greenhouse gases are CO_2, CH_4, N_2O, CFCs, Water vapours etc. These gases are called radiatively active gases because they absorb long wave infra red radiations.

Thus, greenhouse effect can be defined as the phenomenon of keeping the earth surface warm due to the presence of certain radiatively active gases in the atmosphere is called greenhouse effect.

However, due to increase in environmental pollution, among the greenhouse gases in the atmosphere is continuously increasing. It is resulting in slow rise in temperature of the earth. This is known as global warming.

Effects of Global Warming

i) The rise in atmospheric temperature will lead to melting of ice caps and glaciers and inturn increases the sea level. This will lead to submergence of islands and coastal areas.

ii) There may be change in distribution pattern of plant and animal species due to rise in temperature.

iii) There is a continuous change in weather and climatic conditions. Frequency of droughts and floods will increase.

How can we reduce Global Warming?

i) There should be a control on the emission of green house gases such as CO_2, CH_4, N_2O, etc in the atmosphere.

ii) Policy of 3R's i.e. Reduce, Reuse and Recycle should be adopted.

iii) Minimal use of packaging materials.

iv) By promoting afforestation.

v) Reducing deforestation.

vi) Limiting use of fossil fuels by developing alternate sources of energy e.g. solar energy, wind energy etc.

Textual Questions

Q#1 Why are some substances biodegradable and some non- biodegradable?

Ans. Biodegradable substances are mainly of organic nature which can easily be degraded and decomposed through enzymes secreted by decomposers (bacteria and fungi) to be used again. On the other hand non-biodegradable substances are generally man made substances which cannot be degraded or broken down into simpler substances through the enzymes secreted by the decomposing microbes.

Q#2 Give any two ways in which biodegradable substances would affect the environment.

Ans. a) During the decomposition of biodegradable substances foul smell and some harmful gases are
produced which spread in the environment and make the life difficult for the people living in nearby areas.

b) The decomposing material provides ideal medium for the reproduction and growth of flies and microbes which inturn act as vector for several diseases like cholera, typhoid, diarrhea, etc.

Q#3 Give any two ways in which non-biodegradable substances would affect the environment.

Ans. a) Pesticides and related chemicals are non-biodegradable substances. From the
environment through water and food they enter into the living body to cause several harmful effects and also get biologically magnified through food chain.

b) During the process of recycling of non-biodegradable substances like plastic and polythene many toxic substances are released in the environment which through different sources reach human and animal body and cause health problems.

Q#4 What are trophic levels? Give an example of a food chain and state the different trophic levels in it.

Ans. Every step of the food chain where transfer of energy occurs is called as trophic level. The common example of food chain in a terrestrial ecosystem is:

Plant ⟶ Deer ⟶ Tiger

Plant belongs to the first trophic level of the food chain. It is the producer. Deer being a herbivorous animal feeds upon plants and constitutes the second trophic level in food chain and tiger the secondary consumer occupying the third trophic level as it feeds upon deer.

Q#5 What is the role of decomposers in the ecosystem?

Ans. Decomposers are different forms of microbes (bacteria and fungi) who act on the dead bodies of producers and consumers to break the complex organic substances into simpler ones. They absorb some of the substances and release others into environment to be recycled and to be used in future by producers.

In this way decomposers have a very important role in cycling the materials in the biosphere and maintaining the food chain by providing raw materials for producers. They also make the soil fertile.

Q#6 Why is damage to the ozone layer a cause for concern? What steps are being taken to limit this damage?

Ans. i) The thinning of ozone layer results in an increase in the high energy UV- radiations reaching the earth's atmosphere, which causes increased chances of cataract and skin cancer, decreased functioning of immune system, decreased rate of photosynthesis in the plants, etc.

ii) In 1987, UNEP (United Nations Environment Programme)- succeeded in arriving at an agreement to freeze CFCs production i.e., Montreal protocol. Such preventive measures are being analyzed and improved continuously.

Q#7 How can you help in reducing the problem of waste disposal. Give any two methods:

Ans. a) Sorting of biodegradable and non-biodegradable wastes and then dumping the biodegradable waste into preplanned sites to be converted into manure or for land filling.

b) Non-biodegradable materials through incineration may be converted into ash by controlled burning. Ashes obtained by incineration constitute about 10% of the total volume (mass) of the waste material.

Q#8 What are the problems caused by the non-biodegradable wastes that we generate?

Ans. Various non-biodegradable wastes pose various problems such as:

i) Excessive use of weedicides acts as metabolic inhibitors, so it reduces the plant yield.

ii) Excessive use of chemical fertilizers reduces natural bacterial population of soil.

iii) Non-biodegradable solid wastes may block the water drains that cause flooding of area and provide breeding sites for the mosquitoes.

iv) Chlorofluorocarbons (CFC's) released from the refrigerators and air conditioners cause depletion of ozone shield, which increase the amount of cancer causing high energy UV-radiations in the earth's atmosphere.

Q#9 What is biological magnification? Will the levels of this magnification be different at different levels of ecosystem?

Ans. Refer to notes.
The level of these harmful substances will go on increasing from one trophic level to the next. If certain harmful substances enter the food chain at the level of primary producers, they get concentrated many times at each subsequent trophic level.

Q#10 What will happen if we kill all organisms in one trophic level?

Ans. If all the organisms in one trophic level are killed by us, the transfer of food energy to the next and subsequent trophic level will stop. This will cause break in food chain resulting in ecosystem imbalance. Consequently, the organisms of higher trophic level will also die, while the individual of lower trophic level will exhibit enormous growth in their population size. Both the conditions will cause ecological imbalance.

Q#11 Will the impact of removing all the organisms in a trophic level be different for different trophic levels? Can the organisms of any trophic level be removed without causing any damage to the ecosystem?

Ans. i) Yes, the impact of removing all the organisms in a trophic level will be different for different trophic levels e.g., removal of all the producers will adversely affect all the types of consumers including herbivores and carnivores, while the removal of all the herbivores will adversely affect only the carnivores but there will be increase in the number of the producers.

ii) No, removal of all the organisms of any trophic level will always adversely affect the ecosystem, e.g. even the removal of lions and tigers (top carnivores) will cause rapid increase in deer population, which leads to rapid consumption of vegetation resulting in scarcity of vegetation and population crash of deer.

Q#12 If all the waste we generate is biodegradable, will this have no impact on the environment?

Ans. Biodegradable wastes are decomposed by microbes into simpler substances to be used by them and to provide raw materials for producers. But at the same time they have adverse effect on environment.

i) Slow decomposition will result in the release of foul smell, harmful gases and volatile substances into environment, which when inhaled by human beings may cause irritation, nausea etc.

ii) Abundance of microbes may cause disease in animals, plants and human beings.

iii) Increase in the number of microbes in aquatic medium will cause oxygen deficiency in water bodies.

Q#13 What is ozone and how does it affect any ecosystem?

Ans. Ozone is present in the stratosphere of the earth's atmosphere in the form of a protective shield. It contains three oxygen atoms (O_3) which are formed as a consequence of

photochemical reactions in the environment. Ozone absorbs harmful ultraviolet radiations of the sun. In this way, it protects all living beings on the earth. When the ozone layer gets depleted, the UV-radiations reach the earth and plants are the worst suffers. Being producers lying at the base of the trophic level, destruction of plants can upset the whole ecosystem. The planktons present on water surface may die on exposure to UV radiation. This will affect the aquatic ecosystem. UV-radiation causes severe effect on microbes, which are important decomposers in our ecosystem.

Enhanced UV radiations would affect humans and other animals by causing:

- Skin cancer
- Blindness and increased chances of cataract in eyes.
- Malfunctioning of immune system.

Q#14 Multiple Choice Questions:

1. The term ecosystem was introduced by;

b) Miller b) Haldane

c) Tansley d) Darwin

Ans. c) Tansley

2. In a food chain, there is;

a) Bidirectional flow of energy b) Zig zag flow of energy

c) Multi directional flow of energy d) Unidirectional flow of energy

Ans. d) Unidirectional flow of energy

3. Natur's cleaners are;

a) Producers b) Consumers

c) Decomposers d) Carnivores

Ans. c) Decomposers

4. Which of the following groups contain only biodegradable items?

a) Grass, flowers and leather b) Grass, wood and plastic

c) Fruit-peels, cake and lime juice. d) Cake, wood and grass

Ans. Cake, wood and grass.

5. Which of the following constitute a food chain?

a) Grass, wheat and mango b) Grass, goat and human

c) Grass, fish and goat d) Grass, cow and elephant

Ans. b) Grass, goat and human.

6. Which of the following are environment-friendly practices?

a) Carrying cloth-bags to put purchases in while shopping

b) Switching off unnecessary lights and fans.

c) Walking to school instead of getting your mother to drop you on her scooter.

d) All of the above

Ans. d) All of the above

Resource:-The word resource means a source of supply held in reserve. Anything which is useful to man or can be transformed into a useful product or can be used to produce a useful thing can be referred to as a resource. Thus, resource can be defined as a source of supply held in reserve, which is useful to man or can be transformed into more valuable and useful item for mankind.

Natural Resource:- A natural resource is the resource obtained from nature. Natural resources form the very basis of entire life on this planet. Air, water, soil, minerals, sunshine, vegetation, forest, wildlife and fossil fuels are natural resources. Thus, natural resources can be defined as those living or non-living substances available in the normal environment which are being exploited for supporting life and meeting human requirement.

Classification Of Resources:- Natural resources can be classified in different ways. Commonly, natural resources are classified on the basis of their abundance and availability. Under this, the natural resources are grouped into two major categories:

(i) **Inexhaustible natural resources:** Those natural resources which can be renewed by physical, mechanical or chemical processes are called inexhaustible natural resources. These resources cannot be exhausted even after their uncontrolled use by humans. Examples are solar radiation, air, tidal energy, etc.

(ii) **Exhaustible natural resources:** The exhaustible natural resources are those, the stocks of which are limited in nature. These resources if used indiscriminately by humans may get exhausted soon or get degraded in quality. Exhaustible resources are of two types:-

a. **Renewable resources:** These are the resources which can maintain themselves by natural recycling and reproduction or can be replenished if managed wisely. They include forests, crops, domestic animals, wildlife, ground water etc. They can last indefinitely and not likely to be exhausted if a judicious balance is maintained between exploitation and replenishment.

b. **Non-renewable resources:** These are the resources which get exhausted with use because they are not recycled or replenished. They include metallic minerals and fossil fuels (coal, natural gas and petroleum).

Management And Conservation Of Natural Resources

Management is an art of managing a thing or to guide the sources under one's command and control. It may be called as careful and skillful handling of the resources. Conservation may be defined as the proper preservation, management and protection of natural resources for the benefit of all life from destructive influences and misuse of natural resources. In a simple way any measure adopted to check the depletion or destruction of our natural resources is referred to as conservation.

Objectives of conserving natural resources

- Avoiding wasteful use of natural resources.
- Judicious utilization of all natural resources.
- Conserving all non- renewable resources and promoting their sustainable use through recycling and reuse.
- Discovering new resources to fulfill the requirements in order to conserve the exhaustible resources.
- Prevention of all types of pollution (air, water, soil, noise, etc.) in order to conserve and utilize the natural resources judiciously.
- Educating people regarding the outcome of over-consumption of natural resources.
- Maintaining a healthy relationship between economic development and properly balanced utilization of natural resources i.e. sustainable management.

Three R's to save natural resources

- **Reduce:** Natural resources can be saved by their lesser or reduced use. We should avoid unnecessary use of electricity, wasting of food and water, cutting of trees, too much use of automobiles, etc.

- **Recycle**: There are certain resources which can be recycled to be used again. It includes recycling of materials like paper, plastic, glass, metals, etc. which may be recycled to convert them into desired objects.

- **Reuse:** The process of reuse is considered better than recycling because the process of reuse does not require any energy as in the case of recycling. The reuse strategy comprises using things again and again. For example, newspapers and magazines can be used to make envelopes.

Ganga Action Plan

It is a multicrore project and was launched in 1985 because the quality of the water in the Ganga was very poor. Coliform is a group of bacteria, found in human intestine, whose presence in water indicates contamination. The Ganga runs its course of over 2500km from Gangotri in the Himalayas to Ganga Sagar in the Bay of Bengal. It is being turned into a drain by more than a hundred towns and cities in Uttar Pradesh, Bihar and West Bengal that pour their garbage and excreta into it. Largely untreated sewage is dumped into the Ganges every day. In addition, pollution is also caused by other human activities like bathing, washing of clothes and immersion of ashes or un-burnt corpses. And then, industries contribute chemical effluents to the Ganga's pollution load and the toxicity kills fish in large sections of the river.
Ganga Action Plan (GAP) was formulated to reduce the pollution load of river Ganga. Following are the important aspects of GAP.

- Treatment of sewage waste of cities/ towns before its disposal into the river water.
- Enforcement of setting up of effluent treatment plants by the industries.
- Development of ghats and interceptions at strategic locations.
- Construction of community toilets.

Forest Resources

Forests are the invaluable wealth of a country, and a renewable natural resource. About a third of the world's land surface is covered by forests which constitute 90% of the global biomass. Forest ecosystem is dominated by trees and is a great resource, since it provides timber, fuel, wood, fodder, fibres, fruits, nuts, medicines, raw materials and at the same time provides suitable habitat for the wildlife. Forests are the "green gold" of a country. Forests are uncultivated and inhabited land area managed for diverse purposes of forestry, weather covered with trees, shrubs, climbers, etc or not.

Importance of Forests.

Forests have three broad functions- productive, protective and regulative.

Productive functions

- Forests provide timber, fuel wood, fruits, nuts, seeds, medicines etc.
- It provides plant fibres to be used in making ropes and mattresses.
- It provides raw materials for forest based industries for example match sticks, paper industry etc.
- It provides sandalwood, lac, resins etc.
- It is used for making railway sleepers, furnitures and extracting oil for making cosmetics.

Protective functions

- It protects the chemical and physical nature of the soil and prevents the water loss from soil.
- It helps in checking soil erosion by obstructing strong winds and current of water.
- It protects public health by preventing air and noise pollution.
- It intercepts the flood water which in turn helps in recharging ground water resource.
- It acts as gene bank protecting large number of genes for future use.

Regulatory functions

- It influences factors like temperature, humidity and precipitation in order to maintain a conductive natural environment.
- It regulates the climate and rainfall.
- It helps in the regulation of biogeochemical cycles.
- The trees and plants of forests help to maintain a balance between atmospheric oxygen and carbon dioxide.

Deforestation

Deforestation is destruction, reduction or removal of forest cover. There are so many reasons for deforestation but all lead to the destruction of biotic potential of land or desert formation. The main reasons for deforestation are as follows:

Causes of deforestation:-

- **Expansion of agriculture:-** The increasing demand of food has resulted in deforestation to convert forests into agricultural fields.
- **Firewood collection:-** To obtain firewood large number of trees are being cut every year resulting in the depletion of forests.
- **Timber harvesting:-** Felling of forest trees for obtaining timber is an important cause of deforestation.
- **Urbanization and Industrialization**:- Extension of urban areas and establishment of industries are the important factors causing depletion of forest resources.
- **Cattle ranching:-** Large areas of forests have been converted into grazing fields to raise cattle.
- **Fire:-** Fire in forest causes devastating effect on trees and wild animals.
- **Construction of roads, railway tracks and mining:** Are other factors responsible for deforestation.
- **Shifting cultivation (Jhoom Kheti):-** In this method of cultivation, a patch of forest is cleared, vegetation is burnt and ash is mixed with soil to increase fertility. Crop is grown there till the land is fertile, after that the cultivators move to other patch of forest. In this way forests are being destroyed.

Effects Of Deforestation

- Large-scale deforestation has badly affected the weather of our country. There is excessive heating during summers and excessive cooling during winters. The rainfall has also reduced and there are more dust-storms. Global warming is yet another effect of deforestation.
- It destroys the natural habitat of wildlife.
- It leads to the scarcity of timber wood, fuel wood and the wood used in industries.
- It is also an important cause for soil erosion, droughts, floods and landslides.

Stakeholders of forests

Stakeholders are the persons or the company that has invested in business and owns a part of it, or someone who has an interest in the success of a system or organization. The four stakeholders of forests are:

(i) **The people who live in or around forests**: These people depend on forest and forest produce to meet their various needs like timber, firewood, bamboos, fish, fruits, nuts, medicine, fodder, etc. They had been using forest produce judiciously for centuries in sustainable manner till the Britishers took over the command and exploited the forests ruthlessly for their own purposes.

(ii) **The forest department:** After independence, forest department of the government took over the management of the forests. They ignored the needs and experience of the local people and mercilessly cleared the vegetation of huge forest area to convert it for monoculture of eucalyptus, teak or pine.

(iii) **The industrialist:** The industrialists consider the forest as business item and are not interested in its sustainability. They obtain teak, tendu leaves (for making bidis), resin, bamboo, lac and other forest produce for their industries. The business people have a greater reach than the local people. After exploiting one forest they move to another.

(iv) **The wildlife and nature enthusiasts:** They are groups of people who are sincerely interested in conservation of wildlife resources and biodiversity of nature.
Out of the four above mentioned categories of the stakeholders for forest, the local people living in and around forests are most important as without their cooperation, management of forest and protected area cannot be achieved successfully.

Conservation of forests
Conservation of forests is development, management and full protection of existing forest cover so as to provide optimum sustainable yield.
The following measures are suggested for the conservation of forests:

(i) **Afforestation:** Plantation of indigenous or exotic species to develop forests in all the available land from villager's field, road/rail sides to waste lands.

(ii) **Conservation of reserve forests**: Reserved areas include-National Parks, Sancturies, Sacred Groves, Biosphere reserves, etc. Such forests are not allowed to be disturbed. Even the litter is not allowed to be collected from these reserve forests.

(iii) **Social forestry:** It is a kind of afforestation where groups of people raise quick growing multipurpose trees and shrubs on village common lands, vacant lands, roads/ rail sides, etc. Social forestry was started in India by National Commission of Agriculture (NCA) in 1796 to reduce pressure on real forests.

(iv) **Agro-forestry:** It is a kind of afforestation where multipurpose trees, shrubs, horticultural plants and forage plants are grown in fields along with crops. It fulfils the requirement of fodder, fruits, flowers, fuel wood and timber. Agroforestry also reduces pressure on real forests.

(v) **Urban forestry**: Plantation of multipurpose trees, shrubs and flowers/ fruit bearing plants in open lands of urban area is called urban forestry. It helps to check air pollution and reduces noise pollution, besides providing fuel wood, timber, vegetables, fruits and many other products.

People's participation
Active participation of public and their support must be generated in order to conserve our forests and wildlife and to achieve the real goal of eco-development. An example of public participation in conservation of forest and wildlife is the case of the Bishnoi Community in Rajasthan. In 1731, Amrita Devi Bishnoi sacrificed her life along with 363 others for the protection of 'Khejri' trees in Khejrali village near Jodhpur in Rajasthan. In her memory, the government of India has recently instituted Amrita Devi Bishnoi National Award for wildlife conservation.

Chipko Movement
The Chipko Andolan (Hug the Trees Movement) was the result of a grass root level effort to end the alienation of people from their forests. The movement originated from an incident in a remote village called Reni in Garhwal, high-up in the Himalayas during the early 1970s. There was a dispute between the local villagers and a logging contractor who had been allowed to cut trees in a forest close to the village. On a particular day, the contractor's workers appeared in the forest to cut the trees while the men folk were absent. Undeterred, the women of the village reached the forest quickly and clasped the tree trunks thus preventing the workers from felling the trees. Thus, the contractor had to withdraw.
The Chipko movement spread slowly to all nearby areas under the leadership of Shri Sunderlal Bahuguna of Silyara in Tehri region and Shri Chandi Prasad Bhatt of Gopeshwar. Sunderlal Bahugna is now a world famous figure. He presented his plan of this movement at the UNEP meeting held in London in June 1982.
Another example of people's participation in the management of forests is the involvement of local villagers by the West Bengal Forest Department. In 1972, the department realized its failure in reviving the degraded Sal

forests in the Southern districts of the state. The reason was the traditional methods of surveillance and Government's policies which led to clashes between villagers and the forest officials.
After getting defeated, the forest department has changed its strategy at the instance of a farsighted forest officer A.K. Banerjee. Sri Benerjee involved the local villagers in protection of 1,272 hectares of badly degraded sal forest. In return, the villagers were given employement in the both silviculture(management of forests for the production of timber and other wood products) and harvesting operations. They were also allowed to collect fire wood and fodder on a nominal payment. With the active participation of local villagers,
the Sal forests of Arabari became thick and green by 1983. Now the then worthless forest is valued Rs. 12.5 crores. Thus, the people's participation in management of forests gives a significant result.

Wildlife Resources

Life in any form, plant or animal, which exists in its natural habitat is called wildlife. India, because of its unique geographical location and variety of climatic conditions, has been harbouring and giving protection to a large number of wild plants and animals. The vast and beautiful land, extending from Kashmir to Kanyakumari is a habitat of about 75,000 species of animals and a large variety of plants. The wildlife is not only productive and giving economical benefits to the people, but is also an important natural resource responsible for maintaining the ecological balance of our planet.
Man has killed and destroyed large number of wild animals and plants for his material gain, resulting in considerable loss of our wildlife reserves. Wildlife is an exhaustible renewable natural resource and hence its proper management is necessary if we desire to obtain long lasting benefits from it.

Importance of wildlife

(i) Wildlife can be used commercially to earn money through tourism (jungle safari etc).

(ii) It provides best means of sports and recreation.

(iii) It is responsible for maintaining the natural balance of the environment.

(iv) Wild plants act as producers on which thrives the herbivorous animal upon whom depends the carnivorous ones.

(v) The wildlife is deeply related to literature, religion, art, sculpture and culture.

(vi) Study of wildlife helps naturalists to study living organisms in their natural habitat.

(vii) Wildlife is considered as gene bank, which can be used for producing high yielding plants and animals through the process of selection and hybridization.

(viii) Wildlife is a renewable source of large variety of commercial products, like food, fur, lac, musk, leather, feather, ivory, timber, fibre, fodder, fuel, medicines, etc. which can be used from time to time.

Threat to wildlife

(i) **Hunting**: Hunting is the killing of animals for recreation, for food, for safety or for profit through sale of their products. This has led to a remarkable decrease in population of wild animals. Therefore, restrictions are imposed on killing of certain animals (such as lion, tigers, dears, chital, peacocks, etc.).

(ii) **Destruction of habitats**: Population of wild animals is considerably decreased due to (i) Deforestation; (ii) Setting up of dams and reservoirs; (iii) Filling or drainage of wetlands; (iv) Pollution; (v) Urbanization and industrialization etc.

(iii) **Economic consideration:** Some animals are always in great demand for their highly priced articles (e.g., skin, wool, fur, ivory, horn, musk, etc.). Some wild animals are in great demand for various zoos for the world. These economic factors are the basic reasons for destruction of wildlife.

(iv) **Overgrazing by domestic animals:** Forests are destroyed and converted into deserts due to overgrazing by domestic animals and cause a threat to wildlife.

Wildlife conservation

Conservation of wildlife is the management of wild flora and fauna in order to save them from their extinction as well as to get sustainable benefit for both the present and the future generations. Several governmental organizations as well as non- governmental voluntary organizations have been set up to protect the wild life. These organizations aim at:

(i) **Protection of natural habitats:** Natural habitats of wild animals must be protected by identification and safeguard of feeding, resting, breeding and nursing habitats of each species.

(ii) **Maintenance Of Wildlife In Protected Areas**: The wild animals are allowed to grow in number in natural habitats in protected areas by preventing poaching, maintaining habitats and their requirements. This is done by conserving the wild life in-

a. **Biosphere reserves** (i.e., multipurpose protected areas meant for conservation of representative wildlife, traditional life style of tribals and their domesticated animals).

b. **National Parks** (i.e., areas for protection of wildlife maintained by the central government where cultivation, grazing, hunting or other activities are not allowed);

c. **Sanctuaries** (i.e., protected natural habitats where specific wild animals are protected and hunting is not allowed but other activities are allowed. Sanctuaries are maintained by state governments).

(iii) **Protection through legislation:** Wildlife is also protected by a number of Wild Life Acts made by state as well as Union Government. Some of these are listed below:

a. Convention on International Trade in Endangered Species (CITES): It regulates International trades of wild flora and fauna (1976).

b. Indian Board of Wild life (IBWL): It was established in 1952.

c. Wild life (Protection) act, 1972: This act has been uniformly adopted by all states.

d. The Man and Biosphere (MAB) programme of UNESCO: It was started in 1971 for studying Biosphere Reserve.

e. Special Projects for Endangered Species: Project tiger (Initiated on 1st April, 1973); Gir Lion project (1974); Rhinos conservation (1987); Snow Leopard project; Project elephant (1992).

f. The Preservation of Trees Act: It was first introduced in 1975 to protect and regulate felling of trees and to provide space for planting of new trees in those areas. The Act was amended in 1996.

Water Resources

Water is a renewable resource and its availability is maintained through a well regulated hydrological cycle involving a balance between evaporation and precipitation.

Water resources, especially fresh water, are constantly under stress. There are two major threats to this vital natural resource:

(i) Depletion in quantity of water.

(ii) Deterioration in quality of water.

Fresh water is withdrawn from rivers, lakes and groundwater aquifers. Excessive withdrawal of water from these resources may cause depletion in quantity of water in certain places. Deforestation is also a major cause of shortage of rainfall and the subsequent depletion of underground water.

Human activities are mainly responsible for deterioration of water quality. Huge quantity of undesirable substances poured into fresh water reservoir, pollution of underground water with lead, cadmium, arsenic, etc. , eutrophication of natural water, depletion of underground water table are the factors responsible for deterioration in quality of fresh water.

Management and conservation of water resources

Some of the water conservation measures are as follows:

i) **Reduction in wastage of water:** There are three major sectors responsible for water wastage in India- domestic, irrigational and industrial.

a. **Domestic wastage:** It is commonly observed that everybody tends to use more water for his or her domestic use than is actually necessary.

b. **Irrigational wastage**: It is estimated that out of the total quantity of water used for irrigation, only 50% is absorbed by soil and utilized by plants while the rest 50% is lost through evaporation. Through proper management this loss can be minimized to 25%. Drip irrigation, is a modern method through which water is poured slowly near the root of the plant by an efficient and well managed pipeline. This helps in conservation of water.

c. **Industrial wastage**: Huge quantity of water is used in industries for various purposes. Moreover, the water discharged by these industries contains undesirable and toxic substances, causing water pollution. Hot water from factories when discharged into water bodies causes thermal pollution. Through proper management the water intake by industries can be considerably reduced. The water containing industrial effluent should be properly treated or recycled before being discharged into the water reservoirs.

(ii) **Water economy**: It includes water harvesting, reuse and recycling of water.

(iii) **Desalination of ocean water:** Ocean contains a huge quantity of water but because of its high salt content can't be used for domestic or agricultural purpose. Through desalination its excess salt content can be removed and water can be made consumable.

(iv) **Efficient distribution system of water:** Water from places having plenty of it can be transported to water deficient areas as a device of proper water management.

(v) **Afforestation** : Prevents water loss and helps in its conservation.

Dams:- A dam is a barrier for containing water and raising its level. Dams were created with a purpose of protecting and area from flooding, for irrigating fields by diverting the flow of river and to generate hydro electric power. From the dams, bigger canals and smaller canals were connected to supply water to the needy areas for example Indhira Gandhi canal supplies water to many areas of Rajasthan and brought greenery to it.

In India several hydroelectric projects were undertaken by constructing big dams on big rivers like Narmada Valley Project in M.P. (the world's biggest river valley project), the Tehri dam on the Bhagirathi River in U.P., Sardar Sarovar Project in Gujarat, Bodhghat Project in Madhya Pradesh, Hirakund dam in Orissa, Jammu Hydroelectric Project in Jammu and Kashmir, etc.

Benefits of Dams:

Dams are useful for the society in the following ways:

i) Large dams store adequate amount of water which is used for irrigation in fields through a canal system. The canal system originating from dams can transfer large amounts of water to great distances which help to raise agricultural production in far away places.

ii) Large dams ensure continuous water supply in surrounding area. It is also used to supply water in towns and cities through pipelines.

iii) Flowing water from a height is used for generating electricity.

Problems related with Dams:-

(i) **Social aspects:** Uprooting and displacement of large number of peasants and tribes from the area, without adequate compensation and rehabilitation. The people who have been displaced by the construction of Tawa Dam in the 1970's are still fighting for the benefits they were promised. Site of

such projects, being enormous in size, is usually located in backward areas away from the cities and away from villages. The extremely poor and backward people, mostly tribes feel cheated because they seldom get advantage of such schemes.

(ii) **Economic aspects:** Enormous amount of money is spent in constructing very large dams and it does not provide proportionate benefits.

(iii) **Environmental aspects:** Construction of large dam contributes to deforestation of large area of the forests, thus causes loss of biodiversity.

Water harvesting:- Water harvesting is defined as the process of collecting and concentrating runoff water from the run off area into run-on- area, where the collected water is either used directly or stored in the soil profile.

Rain water harvesting:- It is the way to capture the rain water when it rains, store that water above ground or charge the underground and use it later.
The traditional water harvesting techaniques in our country are highly specific for different areas and are variously named as Ahars and Pynes in Bihar, Khadns and Nadis in Rajasthan, Bundhis in M.P. and U.P, Kulhs in Himachal Pradesh, Eris in Tamil Nadu, Surangams in Kerala, Kattas in Karnataka, Bandharas and Tals in Maharashtra, etc.

Main Components of rain water harvesting:-
- Rain water collection
- Storage
- Distribution
- System maintenance

Rain water can be collected from roof top area, or other impermeable surface through a drain pipe. Collected water is kept at least 3 feet away from the foundation of the house. Debris and leaves should be filtered before storing the water by placing screen over the gutter. Storage tank can be placed above or below ground level. The rain water after being store is distributed later one through the regular drip irrigation system.

Water harvesting system occasionally requires maintenance. Debris accumulated over gutters should be cleaned periodically and storage tank should be dried and cleaned when it is convenient to do so.

Benefits of Rain water harvesting
- It provides year round supply of drinking water.
- It provides irrigation water.
- It provides excellent quality water for many domestic purposes.
- It increases ground water recharge.
- It reduces urban floods and stagnation of water during monsoon.
- It reduces storm water discharge preventing soil erosion.
- It decreases the community dependence on ground water for domestic use.

Water shed management:- A water shed is a specific bounded area varying in size and jointly managed by large number of farmers for the purpose of collecting and storing rainwater or water from rivers, streams and groundwater aquifers to be used in future for drinking, agriculture and other purposes.

Fossil Fuels: Coal And Petroleum

Coal and petroleum both are called fossil fuels as they are formed from degradation of organic fossilized matter (remains of animals and plants biomass) under great pressure and heat beneath the earth. They took millions of years to form. Therefore, these are the resources which will get exhausted soon, no matter how carefully we use them. It has been estimated that petroleum and coal, if continued to be used at a rate, they are being used these days, they would be available for about 40 years and 200years respectively.
It is, therefore, essential that alternative source of energy are found at the earliest. Their getting exhausted is not the only reason, for the search of new sources of energy. Another important reason is the pollution, their burning

causes. The fossil fuels when burnt produce carbon dioxide, water, oxides of nitrogen and oxides of sulphur as they are formed of carbon, hydrogen, nitrogen and sulphur. When these fuels are burnt in insufficient air then carbon monoxide is formed instead of carbon dioxide. The oxides of sulphur and nitrogen and carbon monoxide are poisonous. Carbon dioxide, on the other hand is a greenhouse gas. The amount of carbon dioxide is increasing the global warming. Thus, on the above accounts we must search for new sources of energy.

Methods of conservation of fossil fuels

(i) Burning of coal causes air pollution. Thus, direct use of coal for the purpose of burning should be avoided. Coal may be converted into liquid fuel and compressed natural gas (CNG) through coal gasification.

(ii) Techniques should be developed to recover maximum fossil fuels that lie in deep mines and wells. Wastage during extraction and transportation should be avoided.

(iii) Both oil wells and coal mines are prone to catch fires. Therefore, these should be well protected from fire to avoid wastage, pollution and loss of life and property.

(iv) Over-consumption of oil in automobiles should be checked. We must save oil for future use because only a few years are left for its depletion.

(v) Alternative sources of energy, such as hydroelectric, nuclear, solar, wind power and biogas plants should be encouraged.

Major coalfields in India are Jharia, Bokaro, Raniganj, Panch-Kanham, Talchar, Singrauli, Chanda-Werdha, etc. The states having large coal reserves are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. If we compare the future estimated demand with the coal reserves of India, it appears that we have enough coal deposits to last for at least four to five centuries.
The latest survey revealed that offshore deltaic coasts of Godavari, Krishna, Kaveri and Mahananda have fairly good oil deposits. India's crude petroleum production has risen from 2.3 lakhs tons in1950 to about 345 lakhs tons in 2000. An oil reserve in India, at present, is estimated to be 4.45 billion tons. The demand for petroleum is expected to rise upto 164 million tons in India by 2010.

Sustainable Management
Sustainable management can be defined as management of available resources and development of new techniques for the exploitation of natural resources to meet the changing human needs, at the same time maintaining and improving the quality of environment and conserving natural resources.
Sustainability is generally defined as meeting the needs of present generation without compromising the ability of future generations to meet their own need (According to World Commission on Environment and Development, 1987).

Basic practices of sustainable management
It is the time when we should utilize our natural resources in such a way that they may not go waste and last longer. This can be achieved only when we obey the basic practices of sustainability, like

- Rationalized husbanding of all renewable resources and their promotion.
- Conserving all non renewable natural resources by adopting three R's (Reduce, Reuse, Recycle).
- Economy in utilization of resources like drip irrigation to save water loss, controlled extraction of forest wealth to save forests etc.
- Fair sharing of resources in different parts of the world.
- Search for alternative resources to save the natural ones.
- Educating people through mass awareness programme.

Water harvesting designs for rain-fed areas in J&K State:-
Various designs have been recommended depending on the soil, topography, climate, size of the land holding, etc. which could be practiced:

1. **Contour Cultivation:-** Contour are made across the slope and this cultivation of crops, trees etc is carried out. These contours would form barriers across the flow and path of runoff. It is the most effective on moderate slopes. The water is collected in the depressions.
2. **Contour Bunding**:- It is the most popular method practiced on large scale. The practice comprises of constructing narrow based bunds on contour to impound runoff water behind them, so that impounded water is absorbed gradually into the soil profile. The bunds are normally impounded up to a height 30cms. The bunds should be constructed from the top of the catchment and proceeded downwards.
3. **Bench Terracing**:- Bench terracing is another popular method practiced on steep hilly slopes where agriculture practices are common. Bench terracing involves converting the original ground into level step like fields constructed by half cutting and half filling, which reduces the degree of the slope.
4. **Strip farming**:- The cropping is usually intermittent on strips or in rows with catchment area left fallow. The principle lying behind this process is to collect runoff from catchment area to improve soil moisture on the cropped area.
5. **Storing Runoff Water For Recycling:-** In semi-arid areas, summer rainfall is short in duration and comprises of limited rainy days. The intensity of rainfall is high which gives high runoff. This is because high intensity of rainfall has low infiltration rate and runoff rate is therefore, very high.
   Therefore, catchment area, which has low-lying region, is selected and bunded for collection of runoff water.
6. **Check Dams Construction on Nallas and Off-Stream:-** It is a process in which construction of bunds of suitable dimensions across nalla or stream to hold maximum runoff water to create temporary flooding in the stream with arrangements to drain water at suitable intervals is carried out. The water released from bunds will be free from silts and will have very low velocity, which is unable to cause erosion.

Textual Questions

Q#1 Find out about the traditional systems of water harvesting / management in your region.

Ans. Refer to water harvesting

Q#2 Compare the above system with the probable systems in hilly mountainous areas or plains or plateau regions.

Ans. In hilly mountainous areas instead of traditional water harvesting system, check dams are built across seasonally flooded gullies. In this system running water is stored and diverted to the required places. Such water does not remain stagnant for long; hence there is less chance of it becoming polluted like those of pond water.

Q#3 Find out the sources of water in your region / locality. Is water from this source available to all people living in that area?

Ans. In our locality water is available to the people through two major sources:

a) The water is supplied through pipes by municipal board to houses which pay house taxes. Municipalities obtain water mainly through tube wells.

b) The poor people obtain water through hand pumps installed at places. In my locality water is available to all the people.

Q#4 How can you as an individual contribute or make a difference to the management of
(a) forest and wildlife, (b) water resources, and (c) coal and petroleum.

Ans. As an individual I can contribute to conserve these natural resources in the following ways:

a) I will make an extensive campaign of awareness among common people about the significance of forest and wildlife in our life through direct public contact, poster exhibitions and newspaper articles.

b) I will practice myself as well as advice people to rationalize the use of water. At the same time I will adopt water harvesting system and drip irrigation system.

c) I will minimize the use of coal in my house as well as advice my friends and relatives to use non-polluting fuel for cooking. Instead of using my own vehicle, I will move through public transport system to save petrol.

Q#5 List any two measures to be taken for people's participation in conservation of natural resources.

Ans. a) People should be educated about the wise use and conservation of natural resources especially land, water, minerals and forest resources.

b) Conservation projects which involve local communities should be given priority.

Q#6 On the basis of the issues raised in this chapter, what changes would you incorporate in your lifestyle in a move towards a sustainable use of our resources?

Ans. a) I will move in public transport system to conserve petrol.

b) Instead of coal or natural gas I will prefer to use solar energy for cooking.

c) I will obey rationalized husbanding of all renewable resources.
d) I will adopt willingly sustainability as a way of life.
e) I will advice controlled extraction of forest wealth.

Q#7 What changes can you make in your habits to become more environment friendly?

Ans. I will prefer to adopt the following changes in my habits:

a) Do plantation in my courtyard and will develop kitchen garden.
b) Save electrical energy by using it judiciously.
c) Prevent loss of water through leaky taps.
d) Convert kitchen wastes into manure.
e) Instead of using polythene bags, prefer to use cloth bags to carry articles.

Q#8 What is the advantage of exploiting resources with short term aims?

Ans. The advantage of exploiting resources for short term aim is to meet the immediate basic human needs.

Q#9 How do these advantages differ from the advantages of using a long term perspective in managing our resources?

Ans. Short term exploitation of natural resources is to meet the current demand. It is beneficial for the present generation only whereas, management of resources with long term perspective is aimed to fulfill the needs of future generations. Long term use of resources can be achieved through its sustainable use.

Q#10 Why do you think there should be equitable distribution of resources? What forces would be working against an equitable distribution of our resources?

Ans. Equitable distribution of resources will ensure benefits to all the sections of people, rich as well as poor, which is necessary for the growth and development of a country. It will help the resources reach every individual in cheaper and easier way. The people who need to obtain only many out of these resources wood work against it.

Q#11 What changes would you suggest in your home in order to be environment- friendly?

Ans. I will suggest the following changes in my home in order to be environment-friendly:

a) to save energy turn off lights when not in use.
b) Use kitchen wastes as manure.
c) Use drip irrigation for watering the plants.
d) Use cloth bags in place of polythene and plastic bags.

Q#12 Can you suggest some changes in our school which would make it environment –friendly?

Ans. I will suggest the school authority to adopt these environment-friendly measures:

a) grow big trees along the boundary wall.
b) Grow shrubs and hedge on the sides of internal road and around playground.
c) Harvest water from rooftop to be utilized for watering the plants.
d) Arrange awareness programmes among students through poster exhibition and popular lectures.

Q#13 What can you as an individual do to reduce your consumption of the various resources?

Ans. a) I will use public transport system to move instead of individual vehicle.
b) I will use solar cooker to conserve fossil fuel.
c) Instead of lift I will prefer to move through stairs.
d) I will use fluorescent tubes in my home to conserve electrical energy.
e) I will prefer to use renewable source of energy.

Q#14 List five things you have done over the last one week to:

a) Conserve our natural resources.
b) Increase the pressure on our natural resources.

Ans a) Five things that I have done to conserve natural resources are:

1. I converted kitchen wastes into manure.
2. I used only that much of electricity which was required.
3. I kept the water tap closed while brushing my teeth.
4. I convinced my mother to cook the food in solar cooker.
5. I taught my servant about the conservation of natural resources.

b) Five things that I have done to increase the pressure on our natural resources:

1. I went to school on a bike instead of cycle.
2. I forgot to water the plants.
3. I used washing machine to dry up the wet clothes even in sunny days.
4. I asked my gardener to burn the dry leaves.
5. I went along my friends in nearby forest and killed four rabbits.

Q#15 Why should we conserve forests and wildlife?

Ans.
a) They maintain the ecological balance of the environment.
b) They are our gene bank, from where we can harvest useful genes to develop high yielding plants and animals.
c) They have aesthetic, religious, cultural, sculpture and artistic values.
d) They are source of tourism, trade and commerce.
e) Wildlife is useful for performing scientific research.

Q#16 Suggest some approachges towards the conservation of forests.

Ans. Forests can be conserved:
a) By preventing the process of deforestation.
b) By preventing cattle ranching in forest.
c) By promoting afforestation, social forestry and agroforestry.
d) By preventing soil erosion.
e) By regulating fuelwood use and timber harvesting.
f) By mobilizing active people's cooperation.

Q#17 There are four main stakeholders when it comes to forests and wildlife. Which among these should have the authority to decide the management of forest produces?

Ans. In my opinion the people who live in and around forests should be given the authority to decide the management of forest produces because these people are living in forest areas from centuries. They depend on forest produce for their livelihood but at the same time are aware that excessive use of forest produce will be detrimental for their own survival. Hence, they have developed practices to ensure that the resources are used in a sustainable manner.

Multiple Choice Question.

1. Deforestation generally decreases
   a) Rainfall
   b) Soil erosion
   c) Drought
   d) Global warming

Ans. a) Rainfall

2. Non-conventional source of energy is
   a) Coal
   b) Wood
   c) Petroleum
   d) Biogas and solar energy

Ans. d) Biogas and solar energy

3. Greatest problem for water conservation is to reduce the amount of;
   a) Runoff water
   b) Evaporation
   c) Precipitation
   d) Ground water

Ans. a) Runoff water

4. Who are ethologists?

Ans. Scientists who study about animal behavior are called ethologists.